... Theory of Hydro-

72. Lin, Y.K., Probabilistic Theory of Structural

SVIC NOTES

In the first issue of a new year, this column is usually used to reflect on accomplishments and, perhaps, to predict some future activities. The remarks that follow are framed in a similar format, except that the observations are more general in nature. I would like to take a look at the technical information picture, with particular emphasis on information analysis centers.

In the past year, the Federal budget has been significantly reduced. And, although it has received favorable treatment, there has been considerable belt-tightening in the Department of Defense. A hard look has been, and will continue to be, taken at a number of DOD programs. It should come as no surprise that the DOD Scientific and Technical Information Program is being examined for its effectiveness in contributing to the DOD mission. SVIC is one of twenty DOD information analysis centers, and we are facing the same scrutiny. I think this is as it should be. The only question is, how should an evaluation be made, and by whom?

In my opinion, the most logical evaluators of an information service are the users of that service. Since the principal mission of SVIC is to serve the Department of Defense, the best judges of SVIC effectiveness are those members of the shock and vibration community associated with DOD programs. For my part, I think the findings of a representative evaluation team from this community would be most helpful. However, such a team is not easy to pick, at least from the standpoint of formal recognition.

I am therefore appealing for an informal evaluation from those readers of the Digest who feel they have a contribution. I ask those who are willing to address the following five questions in a letter to me.

- Is SVIC demonstrably useful to DOD? If so, how?
- Is SVIC fulfilling a DOD need that is not otherwise being fulfilled?
- Are the SVIC products/services in the best form for DOD needs? If not, what changes are suggested?
- Should SVIC be oriented more towards the R&D or the Acquisition process, or both? Explain!
- Should changes be made in the direction, coverage, products, etc. for SVIC? Give details!

We look forward to a great year. Your comments and suggesti... ...elp. I look forward to hearing from you.

H.C.P.

ANNUAL SERVICE PACKAGE* OF THE SHOCK

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AND VIBRATION INFORMATION CENTER

INFORMATION SERVICES

DIRECT INFORMATION SERVICE*	the Center handles requests for information via mail, telephone, and direct contact. The Center technical specialists, who are experts in the shock and vibration field, have the SVIC computer implemented SHOCK AND VIBRATION INFORMATION BASE at their disposal.
WORKSHOPS	workshops on shock and vibration technology are organized and sponsored by the Center. Experts on specialized technology give lectures and write articles for the workshop proceedings.
SYMPOSIA	annual shock and vibration symposia bring together working scientists and engineers for formal presentations of their papers and for informal information exchanges.

*See inside back cover for details.

EDITORS RATTLE SPACE

VIBRATION TEXTBOOKS

The feature article in this issue of the DIGEST is a survey of vibration textbooks. In the past year many people have asked me to recommend a good textbook on mechanical vibrations. Anyone who has used many reference books involving mechanical vibrations knows that this is not an easy task for the interests of the person making the inquiry vary, and the contents of available vibration texts range from the theoretical to the practical and from mathematical to experimental.

The feature article shows the number of available books and the depth to which they deal with the various aspects of vibration engineerng and practice. Thus, although a wealth of information is available, it remains the job of the engineer to select the right book for his purposes.

Broadly speaking there are many types of books available -- fundamental, applied, special purpose, handbook, and survey. Vibration books have been written by a wide spectrum of engineers from academic to industrial institutions. The special purpose and applied books have to do with many subjects, from random vibrations to machinery diagnostics. They deal in depth with mathematical derivations, calculation and experimental techniques, and practice on varied equipment.

It was not evident to me that the field was so well covered. It had always been my opinion that many gaps exist. Naturally there are areas still not covered by texts. For example, not all of the techniques described in the growing volume of literature have been described in textbooks. In fact, the value of much practical information would be increased if it were extracted from the literature, distilled, and recorded in an organized book. This has occurred in only a few notable special purpose books. There is thus a need for more monographs -- particularly in specialized areas.

R.L.E.

THE LITERATURE OF VIBRATION ENGINEERING

N.F. Rieger*

Abstract. This article contains a review of available textbooks on mechanical vibrations. Books are identified according to their emphasis – fundamentals, applied vibrations, isolation and damping, random vibrations, and testing.

The earliest text on vibration topics was the classic work by Raleigh [1]. This was followed by the works of Timoshenko [2], Morris [3], Hohenemser and Prager [4], Den Hartog [5], Ker Wilson [6], and Biezeno and Grammel [7]. Each of these books was initially written before the computer made possible the solution of complex structures. Two trends are discernable in these early books: first, broad scholarly treatments of vibration problems, with the subject material divided into categories which still remain, i.e., simple, discrete, continua, and non-linear systems; and secondly, applied specializations such as torsional, aircraft and framework vibration, machine vibration and vibration control topics. The early computer years (1950-1960) continued this trend. The vibration books written during this period became more analytical, e.g., Jacobsen and Ayre [8], Timoshenko (3rd edition 1955), Scanlan and Rosenbaum [9], Biezeno and Grammel translation (1954), Church [10], Morse [11], Den Hartog (4th edition 1956), and Bishop and Johnson [12]. The applied books also became more analytical, and increased in diversity, e.g., Norris et al [13], Nestorides [14], Stoker [15], Arnold [16], Dimentberg [17].

Vibration engineering became an important specialization around 1960, due largely to computer developments. Increased emphasis on vibration analysis in engineer training led to the appearance of introductory texts such as Thomson [18], Seto [19], and Vierck [20], though Manley [21] and Mykelstad [22] recognized this need during the 1940's. More recent developments have led to comprehensive basic texts such as Dimarogonas [23], McCallion [24], and to advanced theoretical texts such as Meirovitch [25, 26], Pestel and Leckie [27], and Bishop, Gladwell and Michaelson [28]. The recent fourth edition of Timoshenko, Young and Weaver [29] has also been revised to incorporate matrix theory of shock and vibration and certain computer programs.

In 1967 the Shock and Vibration Information Center (SVIC) initiated its shock and vibration monograph series. To date twelve monographs [30 to 41] on theoretical and applied shock and vibration analysis and measurement have been published. Pusey [42] appears to be the most comprehensive survey of shock and vibration publications yet made. The Table contains a classification of vibration texts into the following general categories.

BASIC REFERENCES

Manley [21] is not widely available but contains a useful introductory treatment of vibration theory with the essential mathematics in complex exponentials, with a discussion of waveform analysis. This is a useful introductory text for practical analysis. Myklestad [22] provides an excellent introductory treatment using complex exponentials and Newtonian methods for single-degree of freedom systems with extensions to multi-degree systems. Church [10] is a general reference which develops the basic introductory theory, and adapts the results to mobility concepts for dealing with complicated problems. This book was written prior to the computer, when special procedures, e.g. mobility, impedance, receptance, etc. for complex systems analysis were in wide usage.

Bishop and Johnson [12] have presented the basic theory of vibration in a rigorous and elegant manner. Both Newtonian mechanics and energy methods are described and the general theory of vibrating systems is developed in terms of receptances.

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Vierk [20] is a basic undergraduate text which covers simple, discrete, and continua systems in fundamental manner, without much practical elaboration. Crandall and Mark [43] is a straightforward introduction to random vibrations, with considerable descriptive background. Seto [19] is a problem-solution approach to vibration instruction, in the manner of the Schaum text books. It touches on a range of applied topics (critical speeds, torsional systems, acoustics) as well as detailed descriptions of equation derivation and solution procedures, e.g. matrix iteration. Meirovitch [25] is a college-oriented analytical text which includes detailed examples of matrix procedures in vibration for discrete systems and continua, in vibration and shock problems.

Thomson [18] is a widely-used text with many well-developed examples which thoroughly covers introductory aspects of most vibration topics. Simple discrete, matrix continua, and random vibrations are introduced. This book contains a good balance of useful techniques and sample applications to current problems, and a different range of topics, e.g., gyrodynamics, rotordynamics, frameworks. Dimarogonas [23] is a basic text which covers a number of applied topics related to the author's practical experience. Tse, Morse and Hinkle [44] is a very comprehensive introductory text which includes a wide range of topics and techniques, with numerical examples. Elementary theory, matrix methods, eigenvalue procedures, and random vibrations are covered in somewhat greater depth than in Thomson [18].

ADVANCED TEXTS

Morris [3] is an early vibration text applied to the problems of aircraft propeller-crankshaft systems. The solutions quoted were limited by the complexity of the examples in those days. Morris and Head [45] discusses the 'escalator' method which they developed to solve such systems, using hand calculators to solve the frequency equations. Mauder [16] deals with a variety of gyrodynamic problems, applied to gyroscopes, rotating disk-shaft systems, etc. An introductory discussion of gyrodynamics applied to solid and flexible bodies is given.

Biezeno and Grammel [7] is a comprehensive discussion of applied vibration problems in rotating and reciprocating machinery. This classic text covers applied vibration theory and solution to problems for steam turbines (critical speeds, disk vibration, blade vibrations) and for large reciprocating engines (torsional systems vibrations, etc.). Great care is given in demonstrating the modeling and the mechanics of each analysis. An excellent glossary of related publications is included. Scanlan and Rosenbaum [9] is applied text, which centers around aircraft structural vibration procedures, though the initial chapters contain a careful development of the basic theory (Lagrangian equations and matrix methods). Tong [46] is an early textbook on advanced vibration theory. It contains important discussions of modal methods, orthogonality and general vibration theory. Pestel and Leckie [27] coordinated the matrix theory of vibrations (and other topics) in their text, and give a variety of sample problems. A comprehensive treatment of matrix analysis of shock and vibration problems is given. Bishop, Gladwell and Michaelson [28] described the matrix theory of vibrations in a general, theoretical manner which included the receptance method. An excellent discussion of numerical methods of that period is included, much of which is still relevant.

Meirovitch [25] is an advanced-level theoretical textbook which deals with matrix methods, modal methods, random vibrations, and related topics in vibration and shock analysis. This book has coordinated advanced mathematical methods for vibration analysis in an effective, eloquent manner. It is also useful as a practical reference sourcebook for advanced techniques suited for computer application in practice.

SPECIALIZED TEXTS

Early evidence of specialization in vibration analysis is evident in torsional vibration, structural vibration, non-linear vibration, acoustics, and modeling and computational techniques. The complimentary development of applied matrix techniques and the digital computer has intensified the development of specialized topics in vibration analysis, and in the related literature. Ten main categories are presently apparent:

Applied Vibrations

Few texts exist in the area of applied vibrations. Macduff and Curreri [47] published a text on ap-

plied machinery vibration control which contains good treatment of balancing, isolation and damping, and torsional vibrations.

The Blake and Mitchell handbook [48] reveals Blake's experience in the petrochemical industry. It was the first practical measurement handbook dealing with industrial machinery. Later Jackson [49] published the practical vibration primer which deals with analysis and control of vibrations in modern turbomachinery. This book deals with techniques, instrumentation, and case histories in machinery vibrations. Mitchell's book [50] on machinery analysis and monitoring, published recently, deals with the practical aspects of machinery vibration. Transducers, conditioners and analyzers, condition measurement, diagnostics and monitoring, and vibration control including balancing and alignment are topics covered.

Richart, et al [51] have published a book on soils and foundations which should be of help to many structural and machinery engineers. The book on natural frequency and mode shape calculation by Blevins [52] featuring many formulas should be of interest to many engineers.

Torsional Vibrations

Classic texts are available by Ker Wilson [53] (fourth edition 1956-1965, five volumes), by Nestorides [14], and by Tuplin [54] (second edition 1966). No modern computer-oriented text on torsional vibrations exists in this field. More recent developments are covered in published papers.

Structural Vibrations

Norris et al [13] is an early computer-oriented preentation of matrix structural analysis, which contains useful practical material on earthquake-proof design of structures, primarily buildings. Hurty and Rubinstein [55] covers matrix vibration theory, modal methods, and an introduction to random vibrations, in a clear manner. Levy and Wilkinson [56] introduces an innovative procedure with a computer program for general structural analysis involving both linear and non-linear analysis. Leissa [57, 58] compiled two excellent monographs on the vibrations of plates and shells. In the area of finite element modeling Kamal and Wolfe [59] and Zienkiewicz [60] have authored monographs. Texts on fluid-structure interactions have been written by Blevins [61] and Davenport [62].

Rotor-bearing System Vibrations

Dimentberg [17] is an analytical book which considers problems of the turbine-generator industry, but without modern computer techniques. Tondl [63] deals with analysis and experiments on rotor stability problems. Analog computer studies are described, but no digital computer work is reported. Fluid-film bearing technology is reported by Pinkus and Sternlicht [64] with reference to bearing dynamics. Lund [65] has reported bearing dynamic properties, and Rieger [66] contains a comprehensive presentation of rotor-bearing dynamics technology. Eshleman [67], Rieger [68], and Loewy [33] are, respectively, comprehensive literature and technology summaries of rotor system critical speed properties, and flexible rotor unbalance response and balancing publications. In addition Loewy contains a good text on fundamental rotor dynamics phenomena. Valuable and practical insights on journal bearing dynamic properties are given in Smith [69] and publications on bearing dynamic properties are discussed in Shapiro and Rumbarger [70].

Random Vibrations

Introductory developments are included as chapters in Thomson [18], Hurty and Rubinstein [55], and Meirovitch [25]. A simple introduction to this topic is given by Robson [71]. Crandall and Mark [43] is an introductory text which deals with the fundamentals and their application to fatigue. Lin [72] gives a comprehensive analytical presentation of stochastic processes applied to vibration and fatigue of structures. Bendat and Piersol [73] is a more recent comprehensive presentation of stochastic processes applied to structures, which incorporated modern Fourier developments.

Noise and Acoustics

The handbook by Harris [74] is a comprehensive survey of industrial noise problems. Beranek [75] is a practical introduction to noise engineering, and Morse [11, 76] contains the theoretical basis for noise analysis. Much of the classic work of Rayleigh [1] is still of use for theoretical noise analysis.

Non-linear Vibrations

Early texts on non-linear vibrations were written by Stoker [15] and Minorsky [77] which emphasized topological methods. The application of harmonic balance procedures to nonlinear problems has been dealt in great detail by Hayashi [78].

Tondl [63] has written several recent monographs on non-linear methods for certain classes of rotor vibration and other problems utilizing computer solution procedures.

Isolation and Damping

Texts on isolation and damping that emphasize the practical aspects of design have been written by MacDuff and Curreri [47] and Harris and Crede [79]. Snowdon's [80, 81] books deal with the high frequency effects in vibration isolation and damping. Optimum shock and vibration isolation has been discussed in the SVIC monographs written by Sevin and Pilkey [35]. Ruzicka and Derby [36] deal with the effect of damping on vibration isolation.

Testing

While no comprehensive, general text dedicated to experimental vibration analysis appears to exist, the SVIC monograph series [32, 34, 37, 38, 40] deals with many topics in this area. Recent microcomputer equipment developments and the present needs of industry for on-site vibration analysis would make such a book a very welcome addition to the subject literature.

ACKNOWLEDGMENT

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TABLE. VIBRATION TEXTBOOKS

BASIC THEORY

AUTHOR	TOPIC	YEAR	CURRENT EDITION	PUBLISHER
Manley, R.	Introductory theory	1942	First	Chapman and Hall
Myklestad, N.O.	Introductory topics	1956	First	McGraw-Hill
Church, A.H.	General Topics mobility	1957	Second	Wiley
Bishop, R. and Johnson, D.	Basic theory	1960	First	Cambridge
Seto, W.	Introductory topics	1964	First	Schaum
Crandall, S. and Mark, W.	Random vibration	1964	Second	McGraw-Hill
Vierck, R.R.	Introductory theory	1967	First	International
McCallion, H.	Basic theory	1973	First	Wiley
Meirovitch, L.	Intermediate theory	1975	First	Wiley
Dimarogonas, A.	General topics	1976	First	West
Tse, Morse, and Hinkle	Introductory theory	1978	Second	Allyn and Bacon
Thompson, W.T.	Introductory topics	1981	Fourth	Prentice-Hall

ADVANCED

Morris, .I.	Applied theory	1928	First	Chapman and Hall
Morris, J. and Head, A.	Technique applications	1944	First	Chapman and Hall
Scanlan, R.H. and Rosenbaum, R.	Applied theory	1951	First	MacMillan
Biezeno, E. and Grammel, R.	Engineering applications	1954	Second	Blackie
Tong, K.N.	Advanced theory	1960	First	Wiley
Arnold, R. and Mauder, L.	Gyrodynamics	1961	First	Academic
Pestel, E. and Leckie, F.	General matrix theory	1963	First	Cambridge
Hurty, W.C. and Rubinstein, M.F.	Applied theory	1964	First	Prentice-Hall
Bishop, R., Gladwell, G., and Michaelson	Matrix analysis	1965	First	Cambridge
Meirovitch, L.	Analytical methods	1967	First	MacMillan
Morrow, C.T.	Shock isolation	1968	First	Wiley
Snowdon, J.	Vibration isolation and damping	1968	First	McGraw-Hill
Sevin, E. and Pilkey, W.	Optimum shock and vibration isolation	1971	First	SVIC

TABLE. VIBRATION TEXTBOOKS (CONTINUED)

SCHOLARLY

AUTHOR	TOPIC	YEAR	CURRENT EDITION	PUBLISHER
Timoshenko, S.P.	General Topics	1928, 1937, 1955, 1974	Fourth	Wiley
Den Hartog, J.P.	General topics	1934, 1940, 1947, 1956	Fourth	McGraw-Hill
Jacobsen, L. and Ayre, R.	General topics	1958	First	McGraw-Hill

APPLIED VIBRATION

Norris, et al	Structural dynamics	1958	First	McGraw-Hill
Macduff, J.N. and Curreri, J.R.	Vibration control	1958	First	McGraw-Hill
Ker Wilson, W.	Vibration engineering	1959	First	Griffin
Mustin, G.S.	Packaging	1968	First	SVIC
Leissa, A.	Vibration of plates	1969	First	NASA
Richart, F., Jr., Hall, J., Jr. and Woods, R.	Soils and foundations	1970	First	Prentice-Hall
Blake, M.P. and Mitchell, W.S.	Machinery noise and vibration	1972	First	Spartan
Leissa, A.	Vibration of shells	1973	First	NASA
Jackson, C.	Practical machine vibration	1979	First	Gulf Publishing
Blevins, R.D.	Natural frequency calculations	1979	First	Van Nostrand Reinhold
Mitchell, J.	Machine monitoring and analysis	1981	First	PennWell Books

TORSIONAL

Ker Wilson, W.T.	Torsional vibrations	1934, 1948, 1965	Third	Wiley
Nestorides, E.J.	Torsional vibration	1958	First	Cambridge
Tuplin, W.	Torsional vibrations	1966	First	Pitman

ROTOR BEARING

Dimentberg, F.M.	Rotor shafts	1961	First	Butterworths
Pinkus, O. and Sternlicht, B.	Hydrodynamic lubrication	1961	First	McGraw-Hill
Tondl, A.	Rotor dynamics	1965	First	Czechoslovakian Academy
Wilcox, J.	Rotor balancing	1967		Pitman
Loewy, R. and Piarulli, V.	Rotor shafts	1969	First	SVIC
Smith, D.M.	Journal bearings	1970	First	Chapman and Hall
Rieger, N.F.	Rotordynamics	1982	Second	Vibration Institute
Rieger, N.F.	Rotor balancing	1982	First	SVIC

GENERAL

Harris, C. and Crede, C.	Handbook on vibration and shock topics	1962, 1977	Second	McGraw-Hill

TABLE. VIBRATION TEXTBOOKS (CONTINUED)

AUTHOR	TOPIC	YEAR	CURRENT EDITION	PUBLISHER
ACOUSTICS				
Rayleigh, L.	Acoustics, advanced	1877, 1894	Second	Dover Reprint 1945
Morse, P.	Acoustics, advanced theory	1953	First	McGraw-Hill
Morse, P.	Theory	1968	First	McGraw-Hill
Beranek, L.L.	Noise and vibration control	1971	First	McGraw-Hill
Harris, C. and Crede, C.	General	1977	Second	McGraw-Hill
NONLINEAR				
Stoker, E.	Non-linear vibrations	1961	First	Academic
Minorsky, N.	Non-linear oscillations	1962		Van Nostrand
Hayashi, C.	Non-linear oscillations	1964		McGraw-Hill
RANDOM				
Robson, J.D.	Introductory	1964		Edinburgh
Crandall, S. and Mark, W.	Applied	1964	First	Academic
Lin, Y.K.	Advanced	1966	First	McGraw-Hill
Lyon, R.	Applied random vibration	1967	First	SVIC
Bendat, J. and Piersol, A.	Stochastic Processes	1980	Second	Wiley
VIBRATION CONTROL				
Macduff, J. and Curreri, J.	Vibration Control	1958	First	McGraw-Hill
Snowdon, J.C.	Applied isolation and damping	1968	First	Wiley
Ruzicka, J. and Derby, T.	Damping and isolation	1971	First	SVIC
Beranek, L.	Noise and vibration control	1971	First	McGraw-Hill
Snowdon, J.C. and Unger, E.E.	Mechanical vibration impact and noise	1973	First	ASME
VIBRATION TESTING				
Enochson, L. and Otnes, K.	Digital time series data	1968	First	SVIC
Kelly, R. and Richman, G.	Shock data analysis	1969	First	SVIC
Curtis, A., Tinling, N., and Abstein, H., Jr.	Vibration testing	1972	First	SVIC
Fackler, W.	Vibration testing	1972	First	SVIC
Bouche, R.	Transducer calibration	1979	First	SVIC

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LITERATURE REVIEW: survey and analysis of the Shock and Vibration literature

The monthly Literature Review, a subjective critique and summary of the literature, consists of two to four review articles each month, 3,000 to 4,000 words in length. The purpose of this section is to present a "digest" of literature over a period of three years. Planned by the Technical Editor, this section provides the DIGEST reader with up-to-date insights into current technology in more than 150 topic areas. Review articles include technical information from articles, reports, and unpublished proceedings. Each article also contains a minor tutorial of the technical area under discussion, a survey and evaluation of the new literature, and recommendations. Review articles are written by experts in the shock and vibration field.

This issue of the DIGEST contains articles about seismic waves and mechanical damping of filled plastics.

Dr. Sasadhar De of W. Bengal, India, has written an article reviewing recent developments in seismology, mathematical methods to study seismic waves, effects of such waves on ground movement and structures, and prediction of earthquakes.

Dr. L.E. Nielsen, science consultant and lecturer, Redmond, Oregon, has written a review on recent important results on the damping of filled plastics.

MECHANICAL DAMPING OF FILLED PLASTICS

L.E. Nielsen*

Abstract. Recent important results on the damping of filled plastics are reviewed. The nature of the plastics-filler interface is especially important in determining the damping of a filled system. Short-fiber composites have damping behavior very different from that of continuous fiber composites. Particle size, particle packing, and particle agglomeration also are important.

During the past few years an active field of research has been the effect of the filler-plastic interface on the mechanical damping of plastics filled with rigid fillers [1-6]. The changes in damping attributable to the interface can result from: a layer of modified polymer near the interface brought about by adsorption of the polymer to the filler surface [1, 2, 4, 5]; a thick interlayer of a different material that binds the polymer to the filler [3]; dewetting or debonding of the polymer from the filler surface [6].

The damping passes through a maximum at a temperature close to the glass transition (softening) temperature of the polymer [7]. Fillers tend to increase the temperature at which damping is a maximum if there is an adsorbed polymer layer on the filler [2, 4, 5]. However, the observed effect in many cases may be due instead to agglomeration of filler particles [8]. In some systems, the damping is given approximately by [1]:

$$\tan \delta = \phi_1 \tan \delta_1 + \phi_2 \tan \delta_2 .$$

In this equation, the damping is δ, ϕ is the volume fraction, and the subscripts refer to the matrix and filler phases.

Fillers can be coated with a layer of a material that is several microns in thickness. For some systems this thick interlayer can greatly increase the damping of a composite containing a rigid polymer [3]. Damping also increases if the adhesion of the polymer to the filler is destroyed; interfacial slippage can then occur [6, 8].

A special type of particulate filler is short fibers or discontinuous fibers. Most of the stress in composites containing continuous fibers is due to low-damping fibers; the damping of the composite material is thus less than that of the polymer and decreases as the concentration of fibers increases. On the other hand, damping of composites containing short fibers can be much greater than that of a pure polymer matrix [9, 10].

Large shear stresses must be present in the plastic matrix of composites containing discontinuous fibers if part of the stress is to be transferred to the fibers. These shear stresses are highest close to the fiber ends. It is this mechanism of stress transfer that gives rise to the high damping of composites containing discontinuous fibers. In any kind of fiber-filled composite damping increases as damage occurs in the composite [11]. The damage often results from dewetting the fiber from the matrix; other forms of damage are also possible.

Mechanical damping is affected by filler particle size [4, 6] and particle shape [12]. Packing and agglomeration of particles also have an important effect on damping. Fedors and Landel [13, 14] have presented a theory of particle packing.

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SEISMIC WAVES

Sasadhar De*

Abstract. ***The article reviews recent developments in seismology, mathematical methods to study seismic waves, effects of such waves on ground movement and structures, and prediction of earthquakes. Directions for future research are given.***

De [1] recently outlined the basic features of seismic waves and mathematical methods. He discussed earthquake prediction and suggested future research in seismology. The present article summarizes the rapid advancement of the subject during the past few years.

SURFACE WAVES AND GUIDED WAVES

Surface waves and body waves have been discussed [1-4]. The Thomson Haskell formulation and the matrix method have been used to study seismic surface wave dispersion functions for layered elastic media. The finite-element technique has been used [5] to study time-harmonic surface waves in irregular, two-dimensional structures. Surface-wave dispersion for an ice sheet – in which velocity and density increase continuously with depth and gradients near the surface are steep -- has been computed [6] by solving the equations of motion using finite differences.

Elastic wave propagation in a laterally and vertically heterogeneous crust has been modeled using the dynamic finite element method (DFEM) [7]. For a buried source in a stratified half-space the surface displacements were calculated by numerical integration of the Fourier-Bessel transform of the response [8]. Slowness methods have been used to study impulsive wave propagation [9]. A general perturbation scheme for analyzing the angular dependence of phase velocity has been formulated [10]. An inverse procedure was developed to obtain exact solutions to one-dimensional seismic waves in elastic, nonhomogeneous media [11]. An ensemble of nonhomogeneous media was assumed in a statistical study of wave propagation [12]. A method to determine the displacement produced in a half-space by arbitrary stresses acting on the surface has been given [13]. The time-dependent solution for a multipolar source in a structure consisting of a homogeneous layer over a homogeneous half-space has been obtained as a sum of generalized rays [14].

Maximum amplitudes and propagation velocities of seismic waves have been investigated at various geological conditions [15]. The attenuation and dispersion of these waves in porous rocks containing spherical gas pockets have been considered using the coupled equations of motion given by Biot [16, 17]. Propagation of nonstationary disturbances in an anisotropic half-space, produced by a point pulse source, has been studied [18], as have antipodal regions of a seismic wave source [19].

A study of the surface P wave radiated by propagating two-dimensional dislocated sources has been presented [20]. The radiated seismic energy is represented as a sum of normal modes; approximate equations are used to describe the dissipation of this energy in the earth by solid friction [21]. The presence of a cavity in the vicinity of a seismic source modifies the radiated signal from the classic solutions for a point force in the finite medium. This effect has been studied and solutions obtained for seismic fields from a point force applied to the surface of a cylindrical cavity in an elastic medium [22]. A nonlinear cumulative frequency-magnitude relation was proposed that fits the experimental data in the high magnitude range [23].

A calculation scheme for Rayleigh wave solutions at higher frequency ranges and higher modes has been published [24], as has a method to determine the

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dispersion function for Rayleigh waves in a layered media [25]. Group velocity distributions of Rayleigh waves, which are expressed in terms of spherical surface harmonics, have been calculated [26]. Lateral heterogeneity of the upper mantle under the ocean was represented by means of contour lines on the maps of group velocity distributions. A set of very high-quality records of first order overtone Rayleigh waves from a deep-focus earthquake has been studied [27]. Such waves in a heterogeneous material, such as multiphase mixtures, composite materials, and polycrystals, are governed by integrodifferential equations derived by known methods for infinite heterogeneous media [28].

A group of Rayleigh waves across a trench is regarded as having four phases [29]: R + tr. R, RS + RRRS, SR + SRRR, and SR S. The transmission coefficients of these phases are obtained separately. An experiment to investigate the capability of a trench to prevent the transmission of Rayleigh waves along the free surface of a half-space has been considered [30].

A linear inversion approach has been used to interpret a wide set of great-circle Rayleigh wave phase velocities in terms of regionalized earth models [31]. NORSAR recordings of Rayleigh waves generated by nuclear explosions in certain regions have been studied [32] and an application of Rayleigh-wave ray tracing has been presented [33].

A numerical method to study surface-wave propagation across vertical discontinuities has been described [34]. The results for Love wave propagation between two, layered quarter spaces were considered. Propagation of Love waves in laterally and vertically heterogeneous layered media [35] and through an ocean-continent transition have been examined using the finite element method and transition excitation [36]. Near-field Love waves (long-period seismic SH waves) have been synthesized by the exact ray method [37], and a finite element technique has been used to study time-harmonic Love waves propagating in three-dimensional structures [38].

The method of integral representation and the Schwinger-Levine variational principle were used [39] to describe the diffraction of plane, harmonic, monochromatic Love waves normally incident upon the plane of discontinuity in a structure consisting of a half-space with a surface step – a model of a continental margin. The form of the transmission matrix was obtained. The method was also used to investigate the two-dimensional problem of the propagation of plane, harmonic Love waves [40].

A method for obtaining partial derivatives of Love-wave group-velocity spectra for a layered medium used a second order perturbation theory [41]. Love waves, whose characteristics are mostly controlled by thick sedimentary layers, have been considered using normal mode theory for given fault parameters [42]. Repeated surface wave group velocity measurements have been made to obtain both Rayleigh and Love wave dispersion data over a number of paths crossing various tectonic provinces of China [43].

The dynamic (amplitude) properties of SH waves propagating in plane-layered transversely isotropic media have been investigated using an asymptotic expansion of the displacement vector [44]. P-wave, SV-wave, and SH-wave velocities have been computed for transversely isotropic solids [45]. The propagation of SH waves in such a plane layered medium was considered using integral transforms and evaluation of steepest descent [46]. A ray-mode duality for such waves in earth models with crust and mantle discontinuities was established [47].

A perturbation method was used [48] to compute numerically the synthetic seismograms that can be observed above a two-dimensional structure on which plane SH waves impinge from below. A procedure has been introduced [49] to determine the reflection coefficients of a layered system when the observed seismic data may contain random noise.

In seismic refraction surveys a hidden layer occurs where energy from a refractor of higher velocity arrives at the surface before energy from an overlying refractor. The maximum thickness of the hidden layer is referred to as the blind zone. The effect of a blind zone on an interpreted depth section can be evaluated by defining an intercept time for a blind zone of assumed or known velocity and by using standard time-term equations for layer thickness and depth [50]. The scattering of harmonic SH waves by an arbitrary surface irregularity has been examined in order to ascertain the effect of topography on seismic ground motion [51]. The canonical problem of the scattering of waves from a harmonic point source in an elastic medium, by an

inviscid fluid-filled cavity, has been examined [52]. A boundary method has been used to numerically solve the problem of scattering of SH waves by a bounded surface cavity in a half-space [53]. The shear phase SS was considered as a tool in the reconnaissance of the earth [54].

The reflection and diffraction of Love waves due to the presence of a vertical crack in an infinite layer of finite thickness attached to a rigid half-space have been studied [55]. Reflections and refractions from curved interfaces have been shown on two-dimensional scale models [56].

An extension of the Thomson-Haskell method to stratified media has been published [57]. The separation of SH and P-SV waves was possible only for spherical, circular, cylindrical, and parallel plane stratifications.

A possible behavior of P- and S-wave velocities at a polymorphic phase transition or melting transition has been investigated [58]. Computation of ray amplitudes of seismic body waves in laterally nonhomogeneous media with curved interfaces was performed during an evaluation of geometrical spreading [59]. Surface wave data have been used to infer the nonhomogeneous structure of crustal and upper mantle, and the continents and oceans over various propagation paths [60]. It has been shown that no large-strain, steady-state creep process in mantle rock can account for a Newtonian, constant viscosity mantle that differs from an analysis of glacial rebound data [61].

In a report of an investigation of surface waves in crystalline media [62-65] Stoneley waves at liquid-crystal and crystal-crystal interfaces were discussed. Love type waves in crystalline media due to the existence of irregular zones at the interface of crust and lower media have been shown [66], and problem of shear modes in anisotropic systems [67] and pure surface modes in orthorhombic materials [68] have been solved.

Seismic waves in inelastic media have been studied [69], and the anelastic nature of the mantle beneath the Pacific ocean has been considered [70]. A simultaneous inversion of both Love and Rayleigh wave dispersion data was shown to be present in the mantle under a restricted form of anisotropy [71]. SH-wave propagation in a poroelastic body has been considered [72], as has the effect of pore fluid on seismic wave propagation [73].

An analytical method has been reported for evaluating generation and dissipation of pore water pressures in sand deposites during earthquakes [74]. Compressional and shear wave velocities have been measured in water-filled Borea sandstone as a function of pore pressure [75]. Such velocities in porous rocks under different saturation conditions were also studied [76]. Love waves in a stratified magnetoelastic solid with material boundary have been discussed [77].

The problem of nonlinear propagation of elastic surface waves has been solved [78]. The effects of gravity on wave propagation in crystalline media have been investigated [63]. It was found that the gravity effect decreases the Rayleigh wave velocity (which is very small) and that this decrement is proportional to wavelength.

The influence of initial stress on wave propagation in crystalline media has been investigated [79], as have surface waves in magnetovisco-elasticity under the influence of such stress [80]. Cauchy's theory of initial stress was introduced to solve the problem of propagation of SH waves in an infinite monoclinic crystal plate [81]. The equations of motion for a prestressed, self-gravitating thermoviscoelastic earth model undergoing a dislocation have been solved by normal mode expansion of the displacement [82]. The long wavelength radiation patterns of P- and S-waves were determined for an elastic prestressed earth model. The effect of nonuniform initial stress in static crack problems has been considered [83], and the problem of seismic radiation from the sudden creation of a spherical cavity in an arbitrarily prestressed medium has been solved [84]. The solution to the latter problem has application to tectonic release resulting from the creation of a shatter zone by large underground explosions. Due to the explosion at the surface, waves are reflected and transmitted at each boundary between two layers. Waves coming back to the surface are recorded. The inverse problem was used to determine from the seismogram, some characteristics of the medium as functions of depth [85].

A method to detect beds of minerals from seismic waves has been reported [62-64]. Reflection seis-

mology has been used [86] to detect locations of and estimate quantities of oil, natural gas, and coal deposits in the earth's sedimentary layers. The reflection amplitude in the detection of shallow gas was considered [87]. Seismology has also been used to determine the best locations for cable plowing, pipe pushes, and underground duct systems [88].

WAVES DUE TO EXPLOSIONS

The activity associated with underground nuclear explosions can be measured from the times of S-P waves. Underwater explosions provide seismic refraction profiles across different oceanic regions. The radiations emitted by high altitude explosions affect the lower ionosphere.

An introductory review of the results of artificial underground explosions from natural seismic events is available [89]. Spectral analyses have been carried out [90] using the maximum entropy method and the fast Fourier transform method for explosion earthquakes that exceeded 10^{15} ergs in seismic energy. Anomalous surface waves from underground explosions have also been considered [91]. A source-time of megaton class nuclear explosions has been determined [92] by modeling teleseismic short- and long-period body waves with synthetic seismograms.

DISTURBANCES IN THE IONOSPHERE

The medium-scale wave disturbances of electron concentrations in the ionosphere are assumed to arise as a result of the propagation of internal acousto-gravity waves. The action on the lower ionosphere (D-layer) of acousto-gravity waves arising in explosions and earthquakes has been analyzed [93], and the effects of waves from earthquakes and volcanic eruptions on the ionosphere have also been investigated [94]. Seismic studies have been conducted simultaneously with longitudinal and transverse waves to obtain lithological information [95].

Earthquake-generated Rayleigh waves excite shock waves at the surface of the earth. These waves propagate upward nearly vertically through the atmosphere as infrasound. Infrasound can be recorded at ionospheric heights with the HF Doppler sounder. Electron density distributions constructed from ionograms can be used to determine the propagation ray paths and delay times for the long-period waves. These data can be used to deduce the dispersion curves for oceanic Rayleigh waves [96].

EARTH'S OSCILLATION

Rayleigh waves correspond to spheroidal oscillations and Love waves correspond to the torsional oscillations. The most general wave equation for determining the period of the free oscillations of the earth for all eigen-vibrations (both spheroidal and torsional) can be written as

$$\rho \frac{\partial^2 u}{\partial t^2} = (\kappa + \mu/3) \frac{\partial e}{\partial x} + \mu \nabla^2 u + \rho X_i$$

The displacement vector is u; e is the dilatation, κ the compressibility, μ the shear modulus, and X_i the body forces.

A theory of pulsation of the earth attributes pulsation to changes in gravity that affect body forces [97]. Various modes, including first and second order perturbation theory and variational methods, have been proposed to calculate the normal modes of a laterally heterogeneous earth [98]. The frequency equation for the infinite set of eigenfrequencies of radial overtones in torsional oscillations of a simple model of the earth has been solved [99]. The Thomson - Haskell matrix method was used to study the radial oscillations of a multilayered elastic sphere due to an explosive source located at the center [100].

A formal classification of spheroidal modes into five families has been discussed [101]. Perturbation theory has been applied to an investigation of the effect of damping on the natural torsional frequencies of the earth [102].

The radial motion of the sold earth (assumed to be a homogeneous elstic sphere) in the presence of a magnetic field in azimuthal direction has been considered [103]. The origin of aperiodic signals during excitation of free oscillations in a nonelastic earth has also been studied [104]. The finite element method has been applied to the eigenvalue problem of a nonhomogeneous earth [105]. Explicit expressions of the Green's dyadics for the toroidal and

spheroidal oscillations of the earth in terms of its normal modes have been obtained [106]. The interesting problem of free and forced vibrations of the earth, including the ocean, has been analyzed using the general euqations of tides and natural vibrations of the earth that take Coriolis forces into account [107].

An earth model with six surfaces of discontinuity between core boundary and surface has been proposed and a pattern of eigenfrequencies presented [108]. Effects of the duration of oscillations in determining earthquake intensity have been shown [109]. The motion excited in a rotating earth model by a kinematically prescribed earthquake fault has been considered in closed form [110]. Expressions for total energy released and energy dissipated by bodily friction subsequent to faulting have been obtained in terms of the normal-mode excitation amplitude. Quasi-periodic variations observed in spacings between successive eigenfrequencies of radial and spheroidal oscillations of the PKIKP type have been considered [111]. The influence of gravity on the free vibrations of a hexagonal plate has been shown [63].

GROUND MOTION AND STRUCTURES

Artificially-induced ground movements and the effects of such movements on structures have been compiled [112]. The nature of earthquakes and current methods of seismic design have been analyzed [113]. Methods for seismic analysis and design and structural and equipment vibration test data have been reviewed [114]. Motion during earthquakes [115] and a concept of earthquake intensity have also been studied [116]. The motion produced by strike slip and shallow dip slip faults has been theoretically investigated [117, 118]. The motion of ground composed of crystalline or granular materials under pressure waves generated by nuclear explosions has been studied mathematically [119, 120]. Cagniard-de-Hoop solutions for a point dislocation in half space were used [121] to construct models of the strong ground motion observed during an earthquake (M = 6.4). The duration of strong ground shaking resulting from nuclear explosions has been discussed [122]. Motions due to small and major earthquakes, canyons of arbitrary shape, the shape and dimension of fault, and the direction of rupture have been presented [123].

Transient and steady-state responses of a model of a one-story building with an embedded foundation subjected to plane horizontally-polarized shear waves have been analyzed [124]. The response of a stratified elastic half-space to a general source was presented in terms of the reflection and transmission properties of the regions above and below the source [125].

The linear theory of ground motions due to earthquakes of small and medium size and nonlinear ground motions during strong earthquakes have been discussed [126]. Two-dimensional horizontal motions during earthquakes and intensity evaluation for the design of structures have been dealt with [127]. An empirical relation has been suggested for the extent of vibration of a building site, the distance of a building from an explosive, the energy cor tent of the explosive, and the frequency of detonating the explosives [128].

The seismic resistance of nuclear reactors [129-131] and the seismic safety of light-water reactors [132] have been discussed, as have the engineering characteristics of earthquake ground motions pertinent to the development of vibratory motion criteria at nuclear plant sites [133]. Seismic responses of underground pipelines [134], multistory steel rigid-frame buildings with set-back towers [135], and steel building frames [136] have been investigated. The behavior of selected low-rise steel buildings subjected to earthquake base motions has been studied [137]. Approximate analyses of the safety of earthquake protection systems with reserve elements have been carried out [138]. The extent to which foundation properties influence the response of some framed structures to earthquakes has been considered [139].

The seismic response due to a traveling shear wave has been investigated [140]; a nuclear reactor building was used. The limitations of subsurface structure in the field of earthquake engineering have been considered [141]. The effects of geological conditions on response spectra and ground motion parameters have been examined [142]. Design spectra for various sites were also presented. Spectral characteristics of ground motion with respect to geological setting have been described [143].

A two-dimensional soil-structure interaction analysis has been carried out [144] for transient Rayleigh

surface waves. Prediction of strong ground motions from earthquakes and the contribution of Love waves have been analyzed [123]. The effect of the duration of ground motion on the dynamic response of hemispherical shells in a fluid medium has been studied [145]. Direct correlations between strong ground motion parameters and damage have been obtained [146]. A technique for synthesizing seismic motions at a given site for an assigned earthquake for the purpose of anti-seismic designing has been developed [147].

PREDICTION OF EARTHQUAKES

Earthquake prediction research [149] and an empirical prediction model [148] have been considered. Recent research on earthquake prediction in Japan has been reviewed, and steps for locating and designing buildings to minimize damage have been indicated [150].

The Vrancea earthquake on March 4, 1977 (M=7.1) was successfully predicted [151]. Tectonic stress field and plate movements in China, an empirical earthquake prediction model, a prediction model from V_p/V_s variations, and seismic activity and crustal movements in Japan have been discussed [152]. Macrobaromic waves (infrasonic and gravity waves) caused by gas outspurts and long period ground movements prior to earthquakes can be detected at a distance [153]. A method to detect earthquakes and determine the arrival time of P and S waves by automatic seismometry system has been considered [154].

Earthquake prediction by continuous observation of crustal movements has been studied [155]. Such predictions generally depend on plate tectonics theory, elastic rebound theory, and the concept of seismic gaps. Large shear stresses in a region and anomalous localized crustal deformations are indicators of the likelihood of an earthquake [156]. The possible average temporal and spatial patterns of foreshocks have been examined [157]. Two models of earthquakes are based on the inclusion theory for dry rocks and on the stress corrosion theory of crack propagation in a wet environment [158]. The predictability of long-period (one second or longer) ground motions generated by long strikeslip earthquakes has been reported [159].

Anomalous tilt behavior has been utilized for earthquake prediction [160]. Correlations have been made between the frequency of earthquakes and the underground water regime in many seismoactive regions [161]. Short- or medium-term risk forecasts and methods for calculating such forecasts have been discussed [162]. The effects of planetary gravitational forces on the earth's surface and on earthquakes have been considered [163], and various statistical parameters have been calculated for frequency - magnitude distributions of earthquakes [164].

Indications of changes in the state of the earth's core, seismic data, changes in the rate of movement of the core, conditions and hydrodynamics of underground waters, and solar-lunar tides have been used for earthquake prediction [165]. The dislocation theory has been applied to seismology on the basis of the mechanics of faulting [166]. Deformations at the earth's surface resulting from the appearance of a soft inclusion have been considered by the small perturbation method [167]. Earthquake sources exhibiting anelastic volume changes have been studied [168] in a gravitating earth. The effect of gravity is compensated by a continuous distribution of volume forces through the earth.

The cause of earthquakes might be related to the movement of the whole earth. Earthquake activity has been related to blocks with boundaries at 45° latitude or longitude [169]. The distribution of distances between pairs of earthquake epicenters and hypocenters have been determined [170] for four local and two worldwide catalogs.

Seismic risk has been calculated from recurrence periods using least squares relations between the number of earthquakes and their magnitude [171]. Periodic changes in the number of earthquakes in Alaska and Central America have been reported and statistically evaluated [172].

Earthquake prediction using a geochemical approach via radon monitoring has been described [173]. Rock rupture is considered a cause of variation of radon content before an earthquake [174]. The anomalous behavior of radon content before and after a strong earthquake has been reported [175, 176]. The largest seismic event can be responsible for the highest radon reading. Variations in radon seem to be correlated with local seismicity [177].

Subsurface soil gas and active faults have been studied [178] to test whether the radon-isotope content shows any changes useful for earthquake prediction. Studies of groundwater radon content in relation to seismic activities have been reviewed [179]. Groundwater radon anomalies can be short in duration and occur only a few days before the main shocks.

The changes of radon concentrations in soil gas associated with certain earthquakes (4.2 - 4.7 M) have been studied [180], as have precursory changes in the radon concentration of groundwater [181]. A remarkable increase in radon concentration occurred after an earthquake. The abnormal characteristics of radon contents in ground water before the occurrence of the 1976 earthquake (M = 7.2) have been analyzed [182].

Diurnal variations of soil-gas helium concentrations have been studied for earthquake prediction [183]. The presence of carbon dioxide - rich springs might indicate a potentially hazardous seismic region [184]. Monitoring carbon dioxide discharges might be useful in earthquake prediction.

The close relationship between gravity variations and the occurrence of earthquakes has been studied [185]. The character and causes of blowing out of gases and emission of sound from dry wells, of water becoming muddy, and the changing water level in wells of the Beijing region immediately before the 1976 Tangshan earthquake and its strong after-shocks have been reported [186].

Anomalies of atmospheric pressure might be indications of the occurrence of earthquakes [187]. A gravity survey has been conducted for the purpose of detecting the gravity change concurrent with subsidence [188]. Tidal effects on seismic activities during the period from 1975 to 1978 have been studied [189]. The peaks of a number of earthquakes were coincident with the time that crustal stress due to semidiurnal tides increased.

Earthquake prediction from the measurement of associated electromagnetic phenomena has been discussed [190]. The piezo-magnetic effect and the dilatancy-magnetic effect in connection with the occurrence of earthquakes have been considered [191]. A theoretical model of an electroelastic continuum has been applied to the problem of electrodynamic phenomena associated with earthquakes [192].

ANIMAL BEHAVIOR

Animals, especially some birds, including domestic fowl, as well as ants, are sometimes more sensitive to earthquake vibrations than humans; they are disturbed when humans do not perceive shocks. Low frequency waves tend to travel fastest and arrive first; these are not so readily felt by humans [4].

Sound is generated before and after an earthquake. Ultrasound caused by seismic waves might explain the strange behavior of animals before an earthquake [193, 194]. Abnormal animal behavior prior to an earthquake has also been studied by Rikitake [195] and others [196]. Seismic acoustics in earthquake prediction has been discussed [197].

CONCLUDING REMARKS

Certain problems [1] are still of interest to scientists. Limited work has been done on nonlinear waves in seismology, and very little attention has been given to surface waves over a thermoelastic crystalline half-space. The transmission of waves through inelastic substances and the periodicity of earthquakes should be studied. Worldwide seismic zones might somehow be arranged in regular directions on the surface of the earth. Study of belts in which earthquakes occur on a spherical surface and the mechanism involved should be determined.

The nature of mantle should be studied from seismic analysis. Emphasis should be given to detecting beds of minerals from the studies of seismic waves.

The coupling between the atmosphere and the ground due to explosions and between the underground earthquake and the atmospheric explosion should be studied. The motion of the earth due to changes in gravity and wave propagation in prestressed media should be topics of research. Research on infrasound caused by seismic waves before earthquakes and on anomalous migration of groundwater and gases should be emphasized.

During the last few years scientists have been actively investigating accurate and reliable techniques for predicting earthquakes. Some kinds of earthquakes have been predicted, and investigations should be continued.

Prevention of earthquakes is the most difficult task; emphasis should be given to preventing such consequences of earthquakes as collapse of buildings and consequent loss of life. Reports regarding designs of structures subjected to seismic excitations are available, but knowledge is still inadequate.

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BOOK REVIEWS

A GENERAL INTRODUCTION TO FRACTURE MECHANICS

A "Journal of Strain Analysis" Monograph,
Mechanical Engineering Publications Ltd., London
1978, 178 pages

This monograph is suitable as a textbook for an introductory course on fracture mechanics for undergraduate or beginning graduate students in mechanics and materials science. Specialists in the field of fracture mechanics were invited to write papers to a predetermined plan; material is presented in logical rather than historical order. The papers are divided into two groups: the first gives the theoretical background of various fracture-mechanics concepts; the second concentrates on practical aspects. The book contains the following chapters:

- Origins of the Energy Balance Approach to Fracture
  by D.J. Hayes
- Origins of the Stress Intensity Factor Approach to Fracture
  by D.J. Hayes
- The Fracture Toughness of Metals
  by J.F. Knott
- Yielding Fracture Mechanics
  by C.E. Turner
- Evaluation of Stress Intensity Factors
  by D.J. Cartwright and D.P. Rooke
- Experimental Methods for Fracture Toughness of Structural Steels
  by R.R. Barr and P. Terry
- Analysis and Application of Fatigue Crack Growth Data
  by L.P. Pook
- Environmental Effects on Crack Growth
  by R.N. Perkins
- Fracture Mechanics: A Summary of Its Aims and Method

Adequate key references in the historical development of the subject of fracture mechanics are also given. The book is very readable and should be a welcome addition to the library of anyone involved in the subject of fracture.

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CREEP OF ENGINEERING MATERIALS

C.D. Pomeroy, Editor
Mechanical Engineering Publications Ltd.,
London, 1978

This monograph contains 12 papers: three on soil and rock by Pomeroy, Bassett, and Ko; one on concrete by Illston; one on bituminous construction materials by Brown, one on ceramics by Wilshire; four on metals by Fessler, Leckie, Goodman, and Frost; and two on polymers and reinforced plastics by Sturgeon and Darlington. Civil engineers will find the articles on soil and rock and the article on bituminous construction materials of interest. Engine component designers will find the silicon nitride information current; parts of the four metal articles will also be of interest. Nuclear and heat exchanger engineers will be particularly interested in the four metal articles and in the UO_2 data of Wilshire. The entire monograph is in common notation, and there is an index.

The complete list of articles is:

1. ***Time-dependent deformation of rocks*** by C.D. Pomeroy
2. ***Time-dependent strains and creep in rock and soil structures*** by R.H. Bassett
3. ***Creep of coal*** by Hon-Yim Ko and K.H. Gerstle
4. ***Creep of concrete*** by J.M. Illston
5. ***Creep of ceramic materials*** by B. Wilshire

6. ***Creep deformation of metals*** by H. Fessler and T.H. Hyde
7. ***Creep rupture*** by F.A. Leckie and D.R. Hayhurst
8. ***Use of existing steel data in design for creep*** by A.M. Goodman and I.W. Goodall
9. ***Some practical examples of creep in metal components and the resulting design problems*** by F.P. Frost
10. ***Creep of fiber reinforced thermosetting resins*** by J.D. Sturgeon
11. ***Creep of thermoplastics*** by M.W. Darlington and S. Turner
12. ***Time-dependent behavior of bituminous materials*** by S.F. Brown

Other general categorizations include fundamental articles by Leckie, Goodman, Sturgeon, Illston, and Darlington. Bassett, Pomeroy, Frost, and Darlington have prepared review articles.

Pomeroy's article on rock begins with such rock creep behavioral modifiers as triaxial compression and temperature. He expresses the factors that influence creep in simple mathematical format.

Bassett's article on rock and soil structures is tutorial but thorough. A discussion of rock and soil mechanics is followed by fundamental time-dependent and stress-strain behavioral models. Elementary mechanics are modified to account for a great number of variables. Many practical cases are discussed; the topics range from foundations and tunnels to crustal movements of the earth.

Ko's and Gerstle's article on coal describes several comprehensive tests on coal samples and humidity effects on coal. Illston's article on concrete begins with a detailed treatment of stress-strain and strain time-response curves. The mathematical formulation of creep laws for all subsegments of the observed experimental behaviors is given. Time under load, age of loading, and theological modeling are included. The Boltzmann superposition is assumed. Effective modulus, creep rates, and flow rates are then derived for direct solutions and numerical computational procedures. Design charts that incorporate the joint European CEB methods are discussed.

Wilshire discusses basic ceramic fracture and creep characteristics. He presents deformation-mechanism maps.

Fessler's article deals only with primary and secondary creep stages. He discusses uniform stress fields and proposes a new method for predicting variable loading whenever significant plastic strains are attained as a result of either load exceedance or temperature change. Stress and temperature variables are not characterized by separate functions. Fessler extends a work-hardening theory to include both plasticity and creep interactions. Variable multiaxial stresses are also considered although the author felt that anisotropy might occur at high strains and cause inaccurate multiaxial expressions. The paper contains numerous references.

Leckie's paper deals with the terminal result of creep; rupture of the material. The emphasis is therefore on the relationships between stresses (invariants) associated with failure. In addition, Leckie analyzes damage by formulating the constitutive equations for creep and damage rates. Damage growth is formulated in terms of void nucleation and growth (both area-wise and volume-wise). Constitutive equations and approximate procedures are covered. An example illustrates ways to identify first failures.

Goodman describes a procedure for utilizing existing creep data in the design of components that operate in the creep range. He assumes steady load and temperature; principal failures occur in creep-rupture and excessive creep deformation. This paper is sufficiently detailed and the processes are explained in general enough terms so that the reader will have no trouble applying the techniques to other materials. Examples are presented for such simple structural elements as a Bernoulli beam and a cylinder-sphere intersection. Methods are presented for data correlation and presentation of new data.

Frost's paper also presents design procedures principally for metals. The specific examples are high-temperature furnace and turbine bucket applications. Sturgeon's paper is addressed principally to individuals unfamiliar with composite materials. Few advanced creep concepts are introduced; the time-dependent strains are the familiar integro-differential-difference representations.

Darlington's paper is a general formulation of polymeric creep behavior. He presents effective moduli for design calculations and processes for time-temperature superposition.

The paper by Brown is thorough and contains a description of the complete creep design of bituminous binder materials in engineering structures. Maxwell and Burger models are used; the reader is shown how to deal with sinusoidal stress, dynamic bitumen stiffness, mix stiffness, uniaxial creep behavior, and the response to repeated loading. The cyclic life (fatigue cracking) of bituminous construction is identified; examples are presented for pavement and rock-filled drums.

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10601 Orchard Lane
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COMPONENT SUPPORT SNUBBERS -- DESIGN, APPLICATION AND TESTING

D.D. Reiff, Editor
ASME Publication PVP-42 (H00169), 1980

Acceptable dynamic performance, especially in seismic structures, requires that the designer and user understand pipe snubbers and their application to piping systems. Effective design criteria for snubbers in pipelines is necessary, including application techniques and meaningful testing and qualification methods.

The book is concise but interesting. Each of the six papers contributes to understanding snubber design and application.

Design considerations for mechanical snubbers are covered in the first paper. The effects of environmental vibrations (nonseismic) induced through piping by pump shaft unbalance and fluid flow oscillations are addressed. Dynamic characteristics and design applications of snubbers are discussed, as are dynamic test requirements.

The second paper has to do with main system piping response during safety/relief valve opening events. The authors measured the stresses in the main steam branch pipe of a boiling water reactor during a safety/relief valve blowdown and compared test results with analytical results. The predicted stresses calculated from current analytical methods used in BWR SRV discharge transient piping response loads were conservative when compared to the measured stress values.

The third paper focuses upon the evolution of snubber qualification testing. The author believes that system evaluation tests will soon be more widely used than diagnostic testing. The reviewer agrees with the author that design evaluation testing should be revised to reflect the results of system evaluation tests.

The next paper considers various aspects of snubber testing: load rating, qualification, endurance, acceptance, and in-service inspection. Special equipment that will soon be used in snubber testing will decrease the development lead time required to market new snubber designs.

The fifth paper considers velocity-limiting mechanical snubber characteristics. The last paper reviews current practices for qualification testing on snubbers as well as interpretation and significance of evaluation tests. The overall qualifications test program provides assurances for meeting environmental requirements, dynamic loading requirements, and in-service inspection requirements.

In summary, snubber design has matured; however, more work and better design testing requirements are needed. The reviewer recommends this book to interested piping designers and analysts.

H. Saunders
General Electric Company
Schenectady, New York 12345

SHORT COURSES

FEBRUARY

VIBRATION AND SHOCK SURVIVABILITY, TESTING, MEASUREMENT, ANALYSIS, AND CALIBRATION

Dates: February 1-5, 1982
Place: Santa Barbara, California
Dates: March 1-5, 1982
Place: College Park, Maryland
Dates: April 12-16, 1982
Place: Dayton, Ohio
Dates: July 19-23, 1982
Place: England

Objective: Topics to be covered are resonance and fragility phenomena, and environmental vibration and shock measurement and analysis; also vibration and shock environmental testing to prove survivability. This course will concentrate upon equipments and techniques, rather than upon mathematics and theory.

Contact: Wayne Tustin, 22 East Los Olivos St., Santa Barbara, CA 93105 - (815) 682-7171.

RELIABILITY ENGINEERING, TESTING AND MAINTAINABILITY ENGINEERING

Dates: February 8-12, 1982
Place: Los Angeles, California

Objective: After completing this course, participants should be able to calculate the failure rates of components and products; construct their Reliability Bathtub curves; determine the early, chance and wearout reliability of components; determine from data the parameters of the times-to-failure distributions of components and products analytically and by probability paper plotting; apply the Chi-Squared and Kolmogorov-Smirnov goodness-of-fit tests; identify the most appropriate distribution to use and couple it with the phenomenological aspects of the underlying life distribution; determine the reliability of systems of any complexity, including series, parallel, standby, load-sharing, multimode function and switching; determine the confidence limits on the reliability for the exponential, normal, Weibull and binomial cases; apply sequential testing and draw up such test plans for the exponential and binomial cases; determine the times-to-restore distribution of equipments when they fail; determine the maintainability of the equipment for a desired maintenance time; combine the reliability and maintainability indices into the overall availability of these equipments; and acquire the skills of applying reliability engineering, reliability testng and maintainability engineering concepts to components, equipment and systems.

Contact: Dr. Dimitri Kececioglu, Aerospace and Mechanical Engineering Department, University of Arizona, Building 16, Room 200B, Tucson, AZ 85721 - (602) 626-2495; or Mr. Robert Rector, UCLA, 6266 Boelter Hall, Los Angeles, CA 90024 - (213) 825-1295.

APPLIED VIBRATION ENGINEERING

Dates: February 15-17, 1982
Place: Daytona Beach, Florida

Objective: This intensive course is designed for specialists, engineers and scientists involved with design against vibration or solving of existing vibration problems. This course provides participants with an understanding of the principles of vibration and the application of these principles to practical problems of vibration reduction or isolation. Some of the topics to be discussed are: fundamentals of vibration engineering; component vibration stresses and fatigue; instrumentation and measurement engineering; test data acquisition and diagnosis; applied spectrum analysis techniques; spectral analysis techniques for preventive maintenance; signal analysis for machinery diagnostics; random vibrations and processes; spectral density functions; modal analysis using graphic CRT display; damping and stiffness techniques for vibration control; sensor techniques for machinery diagnostics; transient response concepts and test procedures; field application of modal analysis for large systems; several sessions on case histories in vibration engineering; applied vibration engineering state-of-the-art.

Contact: Rae D'Amelio, Graduate and Continuing Studies, Union College, Wells House, 1 Union Ave., Schenectady, NY 12308 - (518) 370-6288.

ROTOR DYNAMICS ENGINEERING

Dates: February 15-17, 1982
Place: Daytona Beach, Florida
Objective: This course provides participants with an understanding of the principles and practices of rotor dynamics and the application of these principles to practical problems in rotor dynamics engineering. Some of the topics to be discussed are: theory of applied vibration engineering applied to rotating machinery; vibrational stresses and component fatigue; engineering instrumentation measurements; test data acquisition and diagnosis; fundamentals of rotor dynamics theory; bearing static and dynamic properties; modeling principles for rotor system analysis; practical bearing dynamic properties; bearing characteristics of various bearing types; computer interfacing with instrumentation systems; practical rotor dynamics examples and case histories; rotor balancing theory; balancing of rotors in bearings; rotor stability theory and case histories; rotor signature analysis and diagnosis; rotor-bearing failure prevention; case histories in rotating machinery; state-of-the-art of rotor-bearing technology.

Contact: Rae D'Amelio, Graduate and Continuing Studies, Union College, Wells House, 1 Union Ave., Schenectady, NY 12308 - (518) 370-6288.

VIBRATION TESTING AND SIGNAL ANALYSIS

Dates: February 16-18, 1982
Place: Southampton, England
Objective: Topics include: types of testing: introduction to the various types of signal-linear system theory, etc. (i) testing with applied excitation - techniques - steady state, slow sweep, transient, random, (ii) response analysis (only) - system in motion due to natural excitation; instrumentation and signal conditioning - effects of attachments on system characteristics; instrumentation system characteristics; limitations, e.g. bandwidth, integration, analogue filtering, etc; signal processing; and specific testing.

Contact: Mrs. G. Hyde, ISVR Conference Secretary, The University, Southampton, S09 5NH - (0703) 559-122, Ext. 2310.

CORRELATION AND SPECTRAL ANALYSIS FOR ENGINEERING AND SCIENTIFIC APPLICATIONS

Dates: February 23-26, 1982
Place: San Diego, California
Dates: March 23-26, 1982
Place: Boston, Massachusetts
Objective: This course covers important engineering applications of correlation and spectral analysis relative to acoustics, mechanical vibrations, system identification and fluid dynamics problems in the aerospace, automotive, industrial noise control, civil engineering and oceanographic fields. Applications include identification of system properties and response effects, estimation of time delays and propagation velocities, determination of energy sources, and utilization of practical statistical error formulas to evaluate results. Comprehensive methods are explained to solve single input/single output problems, single input/multiple output problems and multiple input/multiple output problems, where arbitrary correlation and coherence functions (ordinary, partial, multiple) can exist among the records.

Contact: Continuing Education Institute, 10889 Wilshire Blvd., Suite 1030, Los Angeles, CA 90024 - (213) 824-9545; or Continuing Education Institute, Oliver's Carriage House, 5410 Leaf Treader Way, Columbia, MD 21044 - (301) 596-0111.

BALANCING AND ALIGNMENT OF ROTATING MACHINERY

Dates: February 23-26, 1982
Place: Galveston, Texas
Objective: The seminar will emphasize the practical aspects of balancing in the shop and in the field. The instrumentation, techniques, and equipment pertinent to balancing will be elaborated with case histories. Demonstrations of techniques with appropriate instrumentation and equipment are scheduled. Specific topics include: basic balancing techniques (one- and two-plane), field balancing, balancing without phase measurement, balancing machines, use of programmable calculators, balancing sensitivity, flexible rotor balancing, and effect of residual shaft bow on unbalance.

Contact: Dr. Ronald L. Eshleman, Vibration Institute, 101 W. 55th St., Suite 206, Clarendon Hills, IL 60514 - (312) 654-2254.

MARCH

MEASUREMENT SYSTEMS ENGINEERING

Dates March 1-5, 1982
Place: Phoenix, Arizona

MEASUREMENT SYSTEMS DYNAMICS

Dates March 8-12, 1982
Place: Phoenix, Arizona
Objective: Program emphasis is on how to increase productivity, cost-effectiveness of data acquisition systems and groups in the field and in the laboratory. Emphasis is also on electrical measurements of mechanical and thermal quantities.

Contact: Peter K. Stein, 5602 East Monte Rosa, Phoenix, AZ 85018 - (602) 945-4603/946-7333.

MECHANICAL RELIABILITY, DESIGN BY RELIABILITY, PROBABILISTIC DESIGN -- THE STRESS/STRENGTH INTERFERENCE APPROACH TO RELIABILITY PREDICTION

Dates: March 15-19, 1982
Place: Los Angeles, California
Objective: To cover the following: how to predict the designed-in reliability of mechanical components subjected to static and fatigue loads; synthesize the failure covering stress and strength distributions for each component and for each significant failure mode; calculate the associated reliabilities at desired confidence levels, use computer and Monte Carlo simulation techniques to synthesize the failure governing stress and strength distributions and calculate the associated reliability for any combination of these two distributions, design specified reliabilities into components at desired confidence levels.

Contact: Dr. Dimitri Kececioglu, Aerospace and Mechanical Engineering Dept., University of Arizona, Building 16, Tucson, AZ 85721 - (602) 626-2496.

SHOCK AND VIBRATION CONTROL

Dates: March 16-18, 1982
Place: Southampton, England
Objective: Topics include: introduction - structural parameters and their role in vibration control; dynamic properties of structural materials - damping materials and their properties, application of damping treatments to structures, fibre reinforced plastics, fatigue, mobility methods - concepts, system coupling, application to the isolation problem, approximate methods, vibration transmission through structures - path identification - classical, cross correlation, etc., power flow - mechanisms, use of statistical energy methods, acoustic radiation, radiation efficiency; shock - impacts in machines - effects of structural parameters on acoustic radiation, isolation - machinery installations, the transient environment - packaging and packaging materials.

Contact: Mrs. G. Hyde, ISVR Conference Secretary, The University, Southampton, S09 5NH - (0703) 559122, Ext. 2310.

COMPUTER SIMULATION OF HIGH VELOCITY IMPACT

Dates: March 23-25, 1982
Place: Baltimore, Maryland
Objective: This course provides an overview of the response of materials and structures to intense impulsive loading. The various numerical methods available for impact problems are reviewed together with the corresponding material models and failure descriptions. Two- and three-dimensional computer programs for wave propagation, impact and penetration are reviewed, their capabilities and limitations highlighted and computational results compared with experiments where possible. Computer graphics packages for mesh generation and data analysis are also covered.

Contact: Dr. J.A. Zukas, Course Coordinator, (301) 278-2076, or Computational Mechanics Associates, P.O. Box 11314, Baltimore, MD 21239.

COMPUTER APPLICATIONS IN EARTHQUAKE ENGINEERING

Dates: March 29-31, 1982
Place: Chicago, Illinois
Objective: The objective of this seminar is to disseminate information about new computer applications developed from recent research in earthquake engineering. The methodology and computer software in current use, as well as future developments, will be described by the lecturers. Among the topics to be discussed are stochastic analysis of structural systems, linear and nonlinear dynamic analysis of structures, 2D and 3D soil-structure interaction,

multistory building programs, spectral combination method and analysis for multi-component spectra.

Contact: National Information Service for Earthquake Engineering (NISEE), Computer Applications, 519 Davis Hall, University of California, Berkeley, CA 94720 - (415) 642-5113.

APRIL

DESIGN OF FIXED OFFSHORE PLATFORMS

Dates: April 5-16, 1982
Place: Austin, Texas
Objective: This course is dedicated to the professional development of those engineers, scientists, and technologists who are and will be designing fixed offshore platforms to function in the ocean environment from the present into the twenty-first century. The overall objective is to provide participants with an understanding of the design and construction of fixed platforms, specifically the theory and processes of such design and the use of current, applicable engineering methods.

Contact: Continuing Engineering Studies, College of Engineering, Ernest Cockrell Hall 2.102, The University of Texas, Austin, TX 78712 - (512) 471-3506.

MACHINERY VIBRATION ANALYSIS

Dates: April 13-16, 1982
Place: Philadelphia, Pennsylvania
Dates: June 15-18, 1982
Place: Seattle, Washington
Dates: August 17-20, 1982
Place: New Orleans, Louisiana
Dates: November 9-12, 1982
Place: Oak Brook, Illinois
Objective: In this four-day course on practical machinery vibration analysis, savings in production losses and equipment costs through vibration analysis and correction will be stressed. Techniques will be reviewed along with examples and case histories to illustrate their use. Demonstrations of measurement and analysis equipment will be conducted during the course. The course will include lectures on test equipment selection and use, vibration measurement and analysis including the latest information on spectral analysis, balancing, alignment, isolation, and damping. Plant predictive maintenance programs, monitoring equipment and programs, and equipment evaluation are topics included. Specific components and equipment covered in the lectures include gears, bearings (fluid film and antifriction), shafts, couplings, motors, turbines, engines, pumps, compressors, fluid drives, gearboxes, and slow speed paper rolls.

Contact: Dr. Ronald L. Eshleman, Vibration Institute, 101 W. 55th St., Suite 206, Clarendon Hills, IL 60514 - (312) 654-2254.

NEWS BRIEFS: news on current and Future Shock and Vibration activities and events

ENVIRONMENTAL ENGINEERING SHOW
13-15 July 1982
Wembley Conference Centre, London

Environmental Engineering is a major factor in many aspects of modern society, including transport, medicine, the manufacturing industries, packaging, etc. and the importance of understanding new techniques and applications cannot be overemphasized.

Noise and Vibration are emotive subjects and their control is the aspect of Environmental Engineering which receives most publicity. However, in terms of Fatigue, Shock, Materials, Vibration, Noise, Contamination Control, Packaging, Reliability and Durability, Environmental Engineering covers an enormous variety of disciplines which begin in the depths of the ocean and end in deep space.

The technology, the equipment and the services covering the field of Environmental Engineering will all be on view at SEECO 82 under the general title 'Environmental Engineering Today'. Exhibitors will include many internationall renowned companies such as British Aerospace, Plessey and Marconi Avionics.

The event is promoted by the Society of Environmental Engineers. For further information, contact: SEECO 82 Organisers, Owles Hall, Buntingford, Herts. SG9 9PL, England. Tel: Royston (0763) 71209.

CALL FOR PAPERS

INTERNATIONAL MODAL ANALYSIS CONFERENCE

This conference, sponsored by Union College, will be held November 8-10, 1982 at Holiday Inn, Orlando, Florida. Papers are sought on the following topics:

- Structural dynamics
- Finite element analysis
- Computer methods
- Substructuring
- Case histories
- Linking analysis and test
- Analytical modal analysis
- Modal testing software
- Experimental techniques
- Computer graphics
- Structural dynamics modification
- Transducers and instrumentation
- Modeling
- Design methods

Abstracts of the paper (not more than 200 words) should be submitted by March 1, 1982 to: Prof. Raymond E. Eisenstadt, Union College, Graduate and Continuing Studies, Wells House, 1 Union Avenue, Schenectady, New York 12308.

REVIEWS OF MEETINGS

52ND SHOCK AND VIBRATION SYMPOSIUM
27 to 29 October, 1981
Monteleone Hotel
New Orleans, Louisiana

The 52nd Shock and Vibration Symposium, sponsored by the Shock and Vibration Information Center (SVIC), was held in New Orleans in October. It was hosted by the Defense Nuclear Agency and U.S. Army Waterways Experiment Station. The formal technical program consisted of more than 80 papers (see Vol. 13, No. 9 of the DIGEST for the complete program; paper summaries are available from the SVIC; papers will be published in the SHOCK AND VIBRATION BULLETIN). Technical plenary sessions were conducted during the Symposium. Dr. H. Norman Abramson delivered the third Elias Klein Memorial Lecture – "The Changing Dimensions of Qualification Testing." In the second plenary session Dr. Ben Wada of the Jet Propulsion Laboratory gave a talk on the required developments in structural dynamics. A large and interesting session on short discussion topics covering many areas of mechanical vibration and shock was again held. Henry Pusey, Director of SVIC, the members of the SVIC staff, and the Program Committee are to be congratulated for the assembling of an outstanding program on shock and vibration technology. Among the 426 participants were representatives of the federal government, industry, and academic institutions. The combination of formal and informal technical programs effected a meaningful transfer of shock and vibration technology.

The Opening Session

Henry Pusey introduced Colonel Creel, Commander/Director of the U.S. Army Engineer Waterways Experiment Station, who gave the welcome. Colonel Creel discussed the 52 year history of the Station and its activities including control of the nation's waterways. He traced its work from hydraulics, soils, and foundations to structures where they became involved with the Defense Nuclear Agency (DNA). Colonel Creel emphasized their close association with DNA, their cohost for the Symposium.

The opening session, which provided an excellent overview of current U.S. defense thinking on survivability and deployment of weapons, was chaired by Dr. Eugene Sevin of DNA. The keynote address was given by Dr. Marvin Adkins, Director of Offensive and Space Systems, Department of Defense, who spoke on new strategic forces and modernization plans. Dr. Adkins noted that we in the United States have essentially coasted in the defense area since the late 50's and that many weapon systems need upgrading. Current B52 planes are being flown by sons of original pilots. Most money is spent on patch up work. The new administration does not see a future war as a one day event, therefore intensive study has begun on integrated strategic force modernization. Systems need upgrading so that communications and controls are cost effective and strong during war time. They can no longer be a part of existing civilian networks. Thus a whole new communications system is required including better warning satellites and radar. Upgrading the survivability of command centers will enhance endurance effectiveness during attack. The new communications system must endure for a long time after attack.

In the area of aircraft Dr. Adkins emphasized that the B52 needs replacement. It has endured longer than expected due to advances made in structural crack propagation testing. Cruise missiles are needed along with an advanced bomber. He discussed the role of the B1 bomber and its less expensive version the B2B – which will become available in the late 1980's. Also the Advanced Technology Bomber (ATB) which could penetrate Soviet territory was discussed. He discussed the short term projects on upgrading the B52 and the KC135 (for refueling the B52) aircraft.

In the area of sea based strategic forces the Trident submarine and its missiles were discussed along with new larger submarines and cruise missiles. The need to improve accuracy of sea launched missiles was discussed in detail.

The land based missiles including MX were discussed in detail including deployment, response, accuracy, communications, and operating costs. He noted that we are always trying to stay ahead – they add a warhead, we add a shelter. We build the targets, they build the weapons. The U.S. must circumvent this situation. The number of warheads on the new ICBM was discussed along with deployment and hardening of existing silos. Dr. Adkins closed with some overall comments on strategic defenses – the needs in air surveillance, fighter aircraft, anti-satellite systems, and research and development on civil defense. He feels that these items will be hotly debated but that an integrated plan will emerge that the public will understand and support.

The keynote address provided an overview for the four invited papers which were of equal interest. Dr. Charles Davidson of the U.S. Army Nuclear and Chemical Agency discussed equipment survivability on the integrated battlefield. He discussed the combat zone where many different types of weapons could be in use – nuclear, chemical, electronic, and conventional weapons. Joint efforts will be required because no time will be available for transition from one method of warfare to another. The various threats including nuclear, chemical, electronic, and conventional were discussed along with how we plan to deal with them.

Captain Alderson of the U.S. Navy Tactical Nuclear Weapons Project Office discussed naval operations in a nuclear environment. He discussed the modernization of the navy including rebuilding for survivability in a theatre of new threats. EMP, acoustic reverberation, communications blackout, and satellite vulnerability were all discussed. Hardening programs for the navy were discussed. Finally Captain Alderson discussed the challenges for today – developing a structure for establishing and enforcing criteria and rebuilding the navy technology base for nuclear survivability.

Dr. Henry F. Cooper, Deputy for Strategic and Space Systems - Air Force, spoke on survivability requirements for future Air Force strategic systems. Dr. Cooper noted that the Reagan package was the most comprehensive since Eisenhower. He spoke in detail on communications, intercontinental ballistic missiles (ICBM), bombers, sea launched ballistic missiles (SLBM), and strategic defense. New policy trends including deterrence, survivability, and endurance were discussed. The capability for endurance ensures that we will be able to fight after initial attack. Improved survivability/endurance reduces incentive for surprise attack and increases stability. In the area of communications, warning, communication links, and reconstruction capabilities were discussed. ICBM development and deployment were discussed including the trade-off in new deployment areas versus hardening existing silos for the MX. The B1 bomber was discussed in context with B52 and KC135 improvements and the advanced tactical bomber. Strategic defenses including radar coverage, fighter interceptors, and civil defense were discussed. Dr. Cooper closed with a list of future needs – nuclear environments criteria, simulation test development, and design to avoid surprise.

Dr. Edward Conrad, Deputy Director the Defense Nuclear Agency, spoke on nuclear hardness validation testing – discussing what it is and what it does. They maintain a data base on nuclear weapons, provide support on weapon design, conduct tests, and coordinate research. He discussed nuclear environments and the DNA testing program including simulators. Dr. Conrad showed the layout of simulated nuclear tests using high explosives. He discussed the nature of the blast problem – cratering and air blast shock ground wave effects on structures. A good review of the various blast testing techniques was given including the High Explosive Simulation Technique (HEST), mine throw event, and STP-3 combined effects test. Dr. Conrad concluded with the discussion of preservation of reserve forces in mountains and mesas in the event of nuclear attack.

The opening session was concluded with an excellent film on the first flight of the space shuttle – takeoff, operation, and landing.

The Elias Klein Memorial Lecture

The third Elias Klein Memorial Lecture was given by Dr. H. Norman Abramson of Southwest Research Institute on the changing dimensions of qualification testing. This was a very thought provoking presentation on the qualification test philosophies of agencies – specifically the Department of Defense (DoD) and the Nuclear Power Industry (NRC). He discussed the problems of the interface between the vendors,

customers, testing facilities, and regulatory agencies who are trying to achieve a good product at an acceptable cost. The presentation was based on case histories which illustrated the problems encountered in qualification testing and the resulting changes being made to deal with these problems. He noted that in one case (DoD) the objective is "mission integrity" which is achieved by generic testing – the environment is stable. In the other case (NRC) the objective is "operational reliability" which is achieved through custom testing – the environment is an unstable one.

Dr. Abramson discussed qualification testing for the DoD in detail – noting the various environments including temperature, humidity, shock, and vibration. He spoke on qualification testing techniques, simulation of environments, stress levels in service versus those induced during environmental testing. The effects of overtesting and undertesting on equipment reliability were noted. It was interesting to hear the changing philosophies and test techniques – in particular the use of actual environments for testing. The case histories used to illustrate the new methodologies were interesting and provided insight into future testing trends.

Qualification testing in the nuclear power industry was discussed with its organizational and technical problems as well as current thinking and progress. He noted that a major problem for seismic qualification testing is that there is no operational data base. Further aggravation comes from the fact that many organizations are involved in the total qualification process. Dr. Abramson detailed these organizations and their relationship to one another. Again the test methods were discussed along with the problems of over/under test related to the response spectrum. This presentation contained a good overview on the testing techniques, philosophies, and relationship of real world earthquake environments to design of nuclear power plants.

Dr. Abramson closed with some general remarks on environmental testing involving matching the test to the equipment and its intended environment, the frequency range of testing, and the control of dynamic tests. The contents of this excellent presentation will be published in both the SHOCK AND VIBRATION BULLETIN and the SHOCK AND VIBRATION DIGEST. For those involved in environmental testing this should prove to be most interesting and worthwhile reading.

Technical Program

The formal technical program consisted of ten sessions containing full length papers and one session on short discussion topics. A session on rotor dynamics and machinery vibration featured an overview of flexible rotor balancing by Dr. Neville Rieger and a demonstration on shaft vibration and analysis techniques by Donald Bently. Other papers on rotor systems and components, self-excited vibrations, and machine diagnostics were presented.

Environmental testing and simulation was the title of a strong session which contained papers on digital control of shakers, strain gage measurements, environmental simulation, and instrumentation.

Three excellent sessions on the space shuttle – loads dynamics, data systems, and thermal protection system dynamics showed the technology generated by the space shuttle. Don McCutchen of Johnson Space Center is to be congratulated for organization of these sessions. In the session on loads and dynamics, modeling, structural design load procedures, pogo testing, landing loads, and reentry loads were discussed. The technology developed in data systems including processing, screening, and data base management will be of value to many industries. The space shuttle data systems session also contained some good papers on environmental testing. The thermal protection system dynamics was the topic of the last session on the space shuttle. Its structural characteristics, environments, and loads were discussed along with modeling and acoustic emission monitoring. This session also contained several papers on the space shuttle main engine dynamics.

A session on fatigue and random loading contained papers on fatigue life prediction and evaluation, endurance limits, testing technology, fault diagnosis, and indirect Fourier transform and shock analysis. The traditional vibration control, isolation and damping session featured articles on active and optimized vibration control, performance analysis of suspension systems, isolators and cushions, and damping measurements and properties.

Mathematical modeling and structural dynamics were the topics of two mathematically oriented sessions. The modeling session contained papers on structural damping, finite element analysis, determination of mass, stiffness, and damping matrices, structural joint properties, soil models, and stress wave problems. In structural dynamics session lumped parameter models, optimal location of vibration supports, dynamic buckling of shells and columns, composite plates and beams, and vibration and acoustic radiation were discussed.

A session on flight environments featured papers on flap noise, dynamic environments of aircraft, flutter, and flight test data and criteria. The continued large number of short discussion topic presentations shows the popularity of this method of communication at the Symposium – both from the presenter and the attender viewpoints.

The Fifty-second Shock and Vibration Symposium was both technically informative and interesting yielding a large number of excellent papers. Again the plenary sessions with their overviews and philosophical insights added incomprehensible value to the meeting for new and experienced engineers. The Shock and Vibration Symposium continues to be the major annual event in this field and the SVIC can be congratulated for their continued maintenance of the quality of the technical presentations and the organization of interesting update lectures, overviews, and philosophical discussions so necessary for a complete meeting. Papers presented at the Symposium will be reviewed for quality of technical content and published in the 52nd SHOCK AND VIBRATION BULLETIN published by the SVIC.

R.L.E.

INFORMATION RESOURCES

INFRARED INFORMATION AND ANALYSIS (IRIA) CENTER

INTRODUCTION

The Infrared Information and Analysis Center was established in 1954 by the Office of Naval Research (ONR) "to collect, analyze, and disseminate information on research and development in infrared physics and technology with special emphasis on the military applications." In 1964, the IRIA Center was designated a DoD Information Analysis Center, and beginning in February, 1972, the Defense Logistics Agency (DLA) was assigned the funding and administrative responsiblity for IRIA and for eight other contractor-operated DoD Information Analysis Centers. ONR continues as the contracting agency and technical monitor for IRIA through a joint agreement with DLA.

Infrared technology has developed at a remarkable rate since the primitive devices of World War II. Since that time, the technology has benefited from new developments in many technical areas including the introduction of new detector materials, the use of integrated circuit technology, the revolutionary growth of computers, the creation of more powerful methods of pattern recognition analysis, the widespread utilization of lasers, and improvements in reliability and economy through advances in manufacturing methods. These innovations have led to advances in technology not only in the infrared region but also through the much broader electo-optical spectrum, covering ultraviolet, visible, and infrared phenomena. In order to enhance its usefulness to the scientific and technical community, the IRIA Center's technical coverage encompasses most electro-optical systems and their applications, while still maintaining major emphasis on the infrared region.

Although IRIA's mission is primarily directed toward military applications of the technology, similar techniques and equipment are also having major impact in many civilian areas, such as the highly successful Landsat series of remote sensing satellites, which have produced extensive coverage of the land and water surfaces of the earth for varied applications to earth resource management and environmental monitoring.

MISSION

IRIA performs its services to the defense community through several major functions:

- It maintains a comprehensive library of technical information which enables it to respond to technical and bibliographic inquiries of qualified users with necessary security clearance and need-to-know.
- It publishes handbooks and data books, and reports on special state-of-the-art studies and critical reviews conducted by its staff and cooperating scientists and engineers on topics of major current interest.
- It arranges and conducts meetings of the Infrared Information Symposia on behalf of the Office of Naval Research, and other special technical meetings requested and supported by DoD agencies.

The subject areas covered by IRIA include: radiation sources emitting in the ultraviolet through infrared regions; radiation characteristics of natural and man-made targets; optical properties of materials; detection materials, elements, and arrays; lasers; image tubes and sensors; optical systems and components; detector coolers and electronics; atmospheric propagation including absorption, emission, scattering and turbulence effects; and search, homing, tracking, ranging, countermeasures, reconnaissance, and other military infrared and laser systems.

IRIA'S STAFF

The IRIA Center was originally established in 1954 as a part of the Willow Run Laboratories (WRL) of the University of Michigan, because of the heavy concentration of research on all types of sensory systems conducted by WRL. When WRL separated from the university in 1973 to continue as the Environmental Research Institute of Michigan (ERIM), IRIA also transferred to become a part of this newly formed not-for-profit research institute.

The Director the of IRIA Center is Dr. George J. Zissis. Day-to-day operations of the center are supervised by the IRIA manager, Ms. Mildred F. Denecke. IRIA's full-time staff of engineers, physicists, information specialists, and secretarial assistants is responsible for the continuing operation of the Center, while IRIA also benefits from its ability to call on the services of ERIM's scientific staff and its computer facilities. Staff members of the Infrared and Optics Division, of which the IRIA Center is a part, are heavily engaged in research and development for a number of government and industrial sponsors on many advanced projects involving infrared and electro-optical technology.

INFORMATION SERVICES

To provide the Center's staff and its qualified users with a comprehensive source of information on infrared and electro-optical technology, IRIA maintains a library of technical information in these special areas of concentration. The IRIA collection currently numbers over 40,000 books, journal articles, proceedings, contractor reports and government documents, with addition of about 2,000 accessions per year. All accessions are screened and reviewed by technical specialists to classify and summarize the technical content. This review process becomes the basis for the publication of annotated bibliographies of IRIA holdings and the maintenance of a computer-based bibliographic information retrieval system.

In response to user inquiries, IRIA staff members and other technical staff throughout ERIM provide consultation services to the user, directly answering questions or guiding the user to documentation covering his or her special area of interest. Computer-based searches are conducted to retrieve applicable documents and special bibliographies are prepared. The user can order most of the documents of interest to him through the Defense Technical Information Center or can inspect them directly by visiting the IRIA Center.

MEETINGS

Since 1969, IRIA has been responsible for assisting ONR in arranging and conducting the Infrared Information Symposia (IRIS), and the DoD Conferences on Laser Technology. On special request, IRIA also arranges and conducts other meetings which are usually supported by a combination of DoD funding and individual registration fees.

During 1980, seven meetings were held with a total attendance of more than 1900. These meetings represent an excellent opportunity for technical specialists to review and exchange classified information on recent developments in their own areas of interest. The proceedings of these meetings published by IRIA constitute a broad coverage of current technology in each subject area.

SPECIAL PUBLICATIONS

IRIA prepares and publishes a variety of documents to meet special needs of its user audience. Distribution of these publications is controlled by ONR for the Department of Defense.

In 1979, the Infrared Handbook, providing a comprehensive unclassified coverage of infrared technology, was published. By the end of February 1981, nearly 6,000 copies of the handbook had been distributed.

Data books and state-of-the-art reports have been published or are in preparation on various subjects.

AVAILABILITY OF IRIA SERVICES

Currently, IRIA's services, as described above, are available to qualified U.S. organizations through an annual subscription plan. A qualified organization is one with a facility and storage clearance through SECRET and the appropriate need-to-know. Subscriptions cover admission to meetings, receipt of publications and bibliographic and other services of the IRIA Center. The level of services depends on the class of subscription purchased. The annual cost currently ranges from a minimum of $270 to

a maximum of $5,000 (for unlimited use). Nearly 200 industries and universities currently subscribe for IRIA services. In addition both military and civilian employees of DoD agencies and the three services are covered by their blanket subscriptions.

Additional information on IRIA services can be obtained by contacting: Infrared Information and Analysis Center, P.O. Box 8618, Ann Arbor, MI 48107 - (313) 994-1200, Ext. 214.

ABSTRACT CATEGORIES

MECHANICAL SYSTEMS

- Rotating Machines
- Reciprocating Machines
- Power Transmission Systems
- Metal Working and Forming
- Isolation and Absorption
- Electromechanical Systems
- Optical Systems
- Materials Handling Equipment

STRUCTURAL SYSTEMS

- Bridges
- Buildings
- Towers
- Foundations
- Underground Structures
- Harbors and Dams
- Roads and Tracks
- Construction Equipment
- Pressure Vessels
- Power Plants
- Off-shore Structures

VEHICLE SYSTEMS

- Ground Vehicles
- Ships
- Aircraft
- Missiles and Spacecraft

BIOLOGICAL SYSTEMS

- Human
- Animal

MECHANICAL COMPONENTS

- Absorbers and Isolators
- Springs
- Tires and Wheels
- Blades
- Bearings
- Belts
- Gears
- Clutches
- Couplings
- Fasteners
- Linkages
- Valves
- Seals
- Cams

STRUCTURAL COMPONENTS

- Strings and Ropes
- Cables
- Bars and Rods
- Beams
- Cylinders
- Columns
- Frames and Arches
- Membranes, Films, and Webs
- Panels
- Plates
- Shells
- Rings
- Pipes and Tubes
- Ducts
- Building Components

ELECTRIC COMPONENTS

- Controls (Switches, Circuit Breakers)
- Motors
- Generators
- Transformers
- Relays
- Electronic Components

DYNAMIC ENVIRONMENT

- Acoustic Excitation
- Shock Excitation
- Vibration Excitation
- Thermal Excitation

MECHANICAL PROPERTIES

- Damping
- Fatigue
- Elasticity and Plasticity

EXPERIMENTATION

- Measurement and Analysis
- Dynamic Tests
- Scaling and Modeling
- Diagnostics
- Balancing
- Monitoring

ANALYSIS AND DESIGN

- Analogs and Analog Computation
- Analytical Methods
- Modeling Techniques
- Nonlinear Analysis
- Numerical Methods
- Statistical Methods
- Parameter Identification
- Mobility/Impedance Methods
- Optimization Techniques
- Design Techniques
- Computer Programs

GENERAL TOPICS

- Conference Proceedings
- Tutorials and Reviews
- Criteria, Standards, and Specifications
- Bibliographies
- Useful Applications

ABSTRACTS FROM THE CURRENT LITERATURE

Copies of articles abstracted in the DIGEST are not available from the SVIC or the Vibration Institute (except those generated by either organization). Inquiries should be directed to library resources. Government reports can be obtained from the National Technical Information Service, Springfield, VA 22151, by citing the AD-, PB-, or N- number. Doctoral dissertations are available from University Microfilms (UM), 313 N. Fir St., Ann Arbor, MI; U.S. Patents from the Commissioner of Patents, Washington, D.C. 20231. Addresses following the authors' names in the citation refer only to the first author. The list of periodicals scanned by this journal is printed in issues 1, 6, and 12.

ABSTRACT CONTENTS

MECHANICAL SYSTEMS

ROTATING MACHINES

(Also see Nos. 109, 171, 203, 206, 237)

82-1

Estimation of Impact Input Torque in Rolling Mill Drive System When Material Enters the Roll

M. Takeshita, Y. Matsukura, and A. Ishii

Central Res. Lab., Mitsubishi Electric Co., Amagasaki, Japan, Bull. JSME, 24 (192), pp 1037-1043 (June 1981) 10 figs, 4 tables, 7 refs

Key Words: Shafts (machine elements), Torsional vibration, Metal working

The drive shaft system of a steel rolling mill usually vibrates torsionally when a material gets into the rolls. In designing a drive system, it is necessary to grasp the magnitude of transient torque. TAF (torque amplification factor = maximum torque/steady-state torque) is usually applied for this purpose but it occasionally varies with each rolling process. This statistical TAF may depend on variable impact input torque. This paper proposes three functions with the parament β to describe the statistical input torque.

82-2

Improved Mathematical Models and Dynamic Analysis of Light Rotor-Bearing Systems under Unbalance and Stochastic Excitation with Application to a Grinding Machine

E. Hashish

Ph.D. Thesis, Concordia Univ. (1981)

Key Words: Rotors, Flexible rotors, Rigid rotors, Bearings

Detailed stability analysis and accurate evaluation of the response of the light rotor-bearing systems are presented using improved mathematical models for both the rigid and the flexible states of the rotor. The nonlinear stiffness and damping of the finite bearing are specified through a numerical approach maintaining a practical treatment for the cavitation boundaries and leading to decoupled equations of motion from the hydrodynamic pressure equation. Using both linear and nonlinear approaches, modified stability boundaries are defined and further details about the nonlinear behavior are obtained.

82-3

Optimum Friction Damping of a Flexible Rotor

D.H. Hibner, S.T. Dhat, and D.F. Buono

United Technologies Corp., E. Hartford, CT, ASME Paper 81-GT-156

Key Words: Rotors, Flexible rotors, Rolling contact bearings, Coulomb friction

The dynamic response of a multimass, large-scale, flexible rotor mounted on antifriction bearings and a variable force friction damper is investigated both analytically and experimentally. The rotor is a scale model of a gas turbine engine shaft with two critical speeds within its speed range of 0 to 8000 rpm. The experimental results define the under- and over-damped regimes of dynamic rotor response and clearly indicate optimized damping.

82-4

Instability of Rotors in Fluid Film Bearings

J.S. Rao

Rochester Inst. of Tech., Rochester, NY, ASME Paper No. 81-DE-6

Key Words: Bearings, Fluid-film bearings, Rotors, Whirling

This paper is concerned with instability of a rotor that arises due to fluid film forces of a journal bearing. The half frequency whirl and the resulting oil whip phenomena is explained by a consideration of flow balance in a bearing which loses the load carrying capacity.

82-5

Linear Acoustic Formulas for Calculation of Rotating Blade Noise

F. Farassat

NASA Langley Res. Ctr., Hampton, VA, AIAA J., 19 (9), pp 1122-1130 (Sept 1981) 22 refs

Key Words: Helicopters, Rotors, Propeller blades, Noise prediction

A unified approach is used to derive many of the current formulas for calculation of discrete frequency noise of helicopter rotors and propellers. Both compact and noncompact results are derived. The noncompact results are based on the solution of Ffowcs Williams-Hawkings (FW-H) equation. The compact formulations are obtained as the limit of noncompact source results. In particular, the lin-

eorized acoustic theories of Hawkings and Lowson, Farassat, Hanson, Woan and Gregorek, Succi, and Jou are discussed in this paper. An interesting thickness noise formula by Isom and its extension by Ffowcs Williams are also presented.

82-6
A Model for Dynamic Loss Response in Axial-Flow Compressors
M.R. Sexton and W.F. O'Brien, Jr.
Univ. of Virginia, Charlottesville, VA, ASME Paper No. 81-GT-154

Key Words: Compressors, Stalling, Mathematical models

An experimentally determined dynamic loss response function was developed and incorporated in a model to predict the rotating stall behavior of an experimental compressor. The results of the investigation show that the physical mechanisms which control the onset and propagation velocity of rotating stall in a single-stage compressor can be modeled with the use of the loss response function in a semi-actuator disc model of the compressor.

82-7
Acoustic Similarity Law for Centrifugal Fans
W. Neise and B. Barsikow
Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt e.V., Berlin, Germany, Rept. No. DFVLR-FB-80-36, Esa TT-712, 62 pp (Aug 1980) N81-22841
(In German; English Summary)

Key Words: Fan noise, Noise prediction

Acoustic similarity laws for fans were experimentally verified. Three dimensionally similar centrifugal fans of 140, 280 and 560 mm impeller diameter were used. The fans were connected to anechoically terminated discharge ducts. It is shown that the influence of the Reynolds number on the radiated sound pressure is negligible within 140,000 or = Reynolds number or = 2,200,000 which is the range covered by the measurements. This result is in agreement with earlier studies in which the Reynolds number was varied from 14,000 to 450,000. Experimental results support the conclusion that fan noise data which is taken on model fans can be extrapolated to other dimensionally similar fans of different size for arbitrary fan speeds and working fluids, provided that the operating condition and the measurement position are the same.

82-8
Investigation of the Effects of Inlet Shapes on Fan Noise Radiation
T.L. Clark, D.R. Slotboom, and P.G. Vaidya
Boeing Commercial Airplane Co., Seattle, WA, Rept. No. NASA-CR-3416, 49 pp (Apr 1981) N81-22831

Key Words: Fans, Sound propagation, Geometric effects

The effect of inlet shape on forward radiated fan tone noise directivities was investigated under experimentally simplified zero flow conditions. Simulated fan tone noise was radiated to the far field through various shaped zero flow inlets. Baseline data were collected for the simplest baffled and unbaffled straight pipe inlets. These data compared well with prediction. The more general inlet shapes tested were the conical, circular, and exponential surfaces of revolution and an asymmetric inlet achieved by cutting a straight pipe inlet at an acute angle. Approximate theories were developed for these general shapes and some comparisons with data are presented. The conical and exponential shapes produced directivities that differed considerably from the baseline data while the circular shape produced directivities similar to the baseline data. The asymmetric inlet produced asymmetric directivities with significant reductions over the straight pipe data for some angles.

82-9
Experimental Modeling of Unstalled Supersonic Turbofan Flutter
R.E. Riffel and S. Fleeter
General Motors Corp., Indianapolis, IN, J. Aircraft, 18 (9), pp 718-724 (Sept 1981) 17 figs, 2 tables, 8 refs

Key Words: Turbofans, Fans, Flutter

This paper describes the experimental techniques and procedures used to extend the current experimental unsteady rectilinear cascade modeling capability to include the relatively low supersonic inlet Mach number, high pressure ratios, and high reduced-frequency values characteristic of the unstalled supersonic flutter of fan stages. In particular, the cascade modeling concepts, the steady and time-variant experimental techniques, fabrication and instrumentation considerations, data acquisition and reduction procedures, and the correlation of the resulting steady and time-variant cascade data with corresponding predictions are presented.

METAL WORKING AND FORMING

(See No. 1)

STRUCTURAL SYSTEMS

BRIDGES

82-10

Fatigue Behavior of Full-Scale Welded Bridge Attachments

J.W. Fisher, B.M. Barthelemy, D.R. Mertz, and J.A. Edinger

Lehigh Univ., Bethlehem, PA, Rept. No. TRB/NCHRP/REP-227, ISBN-0-309-03033-1, 57 pp (Nov 1980)

PB81-161754

Key Words: Beams, Plates, Bridges, Steel, Fatigue life

The findings of an extensive laboratory evaluation of the fatigue behavior of welded steel bridge members are reported. The objective of this study was to examine the fatigue strength of beams with web and flange lateral attachment plates. In addition to providing a more comprehensive data base for this type of detail, the program was intended to examine the influence of lateral bracing members on the out-of-plane distortion of the lateral plates. Further work also was undertaken during the experimental studies on the effectiveness of peening and gas tungsten arc remelting the fatigue-damaged connections and on the ability of drilled holes to arrest crack growth.

BUILDINGS

(Also see Nos. 95, 148, 149, 150, 222, 234)

82-11

Aircraft Sonic Boom: Effects on Buildings. 1964 - March, 1981 (Citations from the NTIS Data Base)

National Technical Information, Springfield, VA, Rept. for 1964 - March 1981, 84 pp (April 1981)

PB81-805673

Key Words: Sonic boom, Buildings

Research findings are cited on the effects of sonic booms on buildings, structural components, forms, windows, and walls. Test-house investigations are included, along with damage analysis and vibration response. Documentation is made on residential buildings. Other topics contained in the volume range from theory to failure analysis. Sonic boom propagation and effects on biological forms, including human responses, are cited in separate bibliographies.

82-12

Structureborne Sound in Buildings: Needed Practical Research in Light of the Current State of the Art

E.E. Ungar

Bolt, Beranek and Newman, Inc., Cambridge, MA, Rept. No. BBN-4309, NBS-GCR-80-248, 57 pp (June 1980)

PB81-187064

Key Words: Buildings, Structure-borne noise

An overview of the current state-of-the-art of structure-borne sound in buildings is presented. A general introduction to the field of structureborne sound is included with a discussion of important phenomena. Summaries of recent investigations described in the technical literature are discussed relevant to excitation and local response, propagation, radiation, and control of structureborne sound in buildings. Topics for future research in structureborne sound in buildings are presented based upon this review. An annotated bibliography of recent investigations is appended.

82-13

Sound Transmission through Building Structures - Review and Recommendations for Research

B.H. Sharp, P.K. Kasper, and M.L. Montroll

Wyle Labs/Wyle Research, Arlington, VA, Rept. No. WR-80-21, NBS-GCR-80-250, 146 pp (July 1980)

PB81-187072

Key Words: Buildings, Sound transmission

A critical review of the status of technology in sound transmission through building structures is presented and specific areas for further research are identified. The approach taken in the review follows the steps involved in the design process; namely, prediction, measurement, and evaluation. Priorities for further research are based on the potential for achieving the following objectives: to develop new technology to reduce the cost of noise control in buildings; to increase confidence that designs will provide the required acoustical privacy; and to identify and apply sound isolation techniques that reduce energy consumption.

82-14

Dynamic Properties of an Eight-Story Prefabricated Panel Building

J.G. Bouwkamp, J.P. Kollegger, and R.M. Stephen
Earthquake Engrg. Res. Ctr., California Univ., Berkeley, CA, Rept. No. UCB/EERC-80/30, NSF/RA-800407, 83 pp (Oct 1980)
PB81-200313

Key Words: Buildings, Multistory buildings, Interaction: structure-foundation, Resonant frequencies, Damping, Mode shapes

The results of forced and ambient vibrations studies of an eight-story apartment building, constructed with prefabricated wall panel and slab elements are presented. Dynamic characteristics, such as resonant frequencies, damping, and vertical and horizontal mode shapes of the structure were determined and correlated with analytical results using the computer program TABS-77. Rigid floor diaphragm action and serious structure-foundation interaction were observed. Including the foundations flexibility in the analytical model resulted in resonant frequencies and mode shapes showing excellent agreement with the test data. The results of full scale dynamics studies of another, structurally identical, 12-story apartment building with a basically identical floor plan, are also presented and indicate a direct proportionality between structural height and fundamental periods.

82-15

Identification of Hysteretic Behavior for Existing Structures

S. Toussi and J.T. P. Yao
Purdue Univ., School of Civil Engrg., Lafayette, IN, Rept. No. CE-STR-80-19, NSF/RA-800422, 62 pp (Dec 1980)
PB81-178113

Key Words: Buildings, Seismic response, System identification techniques

Two methods of system identification were developed for the estimation of structural behavior during earthquakes. Because earthquakes data are normally available from only a small number of locations in structure, and input as well as output noise exist in the records, it is easier to estimate the parameters of the dominant modes in the record rather than all the elements in the stiffness and the damping matrices of the structure as a whole. This assumption makes it possible to consider the model as a single-degree-of-freedom system even when the response spectrum shows the presence of other modes. Results of a simulation study are presented along with the response data of the Union-Bank building during the 1971 San Fernando Valley earthquake.

82-16

Earthquake-Excited Oscillations of Rigid Buildings on Stratified Grounds

K. Roennberg
Thesis, Karlsruhe Univ., Germany
INIS-mf-5581
(In German)

Key Words: Buildings, Seismic excitation, Interaction: structure-foundation, Nuclear reactors, Nuclear power plants

The dynamic interaction between the ground and the buildings on stratified building grounds is examined. The vibrational behavior of buildings is examined which stand on the surface of a ground layer without lateral borders, which lies on an elastic-isotropic half-space. The vibrational response of the ground-building system is determined on load by means of a harmonic exciter function and diverse earthquake time curves. For some ground models, the filtering influence of the layer on the acceleration at its bottom edge is examined. The determined 'modified' free panel acceleration is used for the loading of the ground-building system. The building properties correspond to those of a typical reactor building of a nuclear power plant. For the setting-up of the equation of motion of the ground-building system, of the theory of the elastic-isotropic half-space and the elongation for the case of stratified ground are applied.

82-17

An Evaluation of Inelastic Seismic Design Spectra

S.A. Mahin and V.V. Bertero
Dept. of Civil Engrg., Univ. of California, Berkeley, CA, ASCE J. Struc. Div., 107 (9), pp 1777-1795 (Sept 1981) 11 figs, 2 tables, 43 refs

Key Words: Seismic design, Multistory buildings, Buildings

After reviewing general methods available for determining seismic design forces for structures which can tolerate limited amounts of inelastic deformations, the reliability of two representative procedures is evaluated. In the methods evaluated, inelastic design response spectra are obtained by modifying a linear elastic design response spectrum in terms of a specified ductility factor. The effect of different accelerograms, as well as of different system damping and hysteretic characteristics, on the inelastic response of single degree-of-freedom systems designed using these methods is thoroughly investigated, considering maximum displacement ductilities, maximum and permanent drifts, number of yield events, and hysteretic energy dissipation.

82-18

Data Analyses for Safety Evaluation of Existing Structures

S.-J. Hong Chen and J.T.P. Yao

School of Civil Engrg., Purdue Univ., Lafayette, IN, Rept. No. CE-STR-80-18, NSF/RA-800423, 100 pp (Dec 1980)

PB81-186074

Key Words: Buildings, Seismic excitation, Safety factor, Natural frequencies, Damping coefficients, System identification techniques

The state of structural safety is evaluated by using rational indicators which are related to the physical deterioration of existing structures. Two such indicators – natural fundamental frequency, and damping ratio are studied. An approach for safety evaluation of existing structures utilizing system identification techniques is emphasized. Specifically, changes of estimated parameters such as natural frequencies and damping ratios during an earthquake are correlated with the observed structural damage. The application of simple methods of system identification to existing structures from observations of responses to earthquake inputs is elucidated. Numerical examples of two existing buildings and two test structural models with various damage levels are given to demonstrate the effectiveness of these new methods.

FOUNDATIONS

(Also see Nos. 243, 244, 245, 246, 247)

82-19

Determination of the Dynamic Material Properties of Soils from the Results of Static Shear Tests

E. Kavazanjian, Jr. and T. Hadj-Hamou

Stanford Univ., John A. Blume Earthquake Engrg. Ctr., CA, Rept. No. NSF/RA-800424, 47 pp (June 1980)

PB81-178170

Key Words: Soils, Dynamic properties

This report reviews the applicability of several recently developed elasto-plastic and endo-chronic constitutive theories for predicting dynamic soil behavior with parameters determined from static shear tests. Based on this review, a simple procedure for predicting equivalent linear shear modulus and the fraction of critical damping from the results of triaxial compression tests with an unload-reload cycle is developed. The applicability of this procedure is demonstrated on two different soils – Crystal Silica sand and San Francisco Bay mud. Results show the procedure may be useful for preliminary analysis and in situations where more sophisticated testing apparatus are not available.

82-20

Dynamic Response of Flexible Rectangular Foundations on an Elastic Half-Space

M. Iguchi and J.E. Luco

Dept. of Appl. Mechanics and Engrg. Sciences, Univ. of California at San Diego, Rept. No. NSF/RA-800443, 34 pp (Mar 1980)

PB81-176638

Key Words: Interaction: soil-foundation, Foundations, Flexible foundations

An approximate method for the analysis of the dynamic interaction between a flexible rectangular foundation and the soil with consideration of the out-of-plane deformation of the foundation is reported. The procedure is based on an extension of the subdivision method developed by Wong and Luco for rigid foundations. Numerical results describing the influence of the flexibility of the foundation on the vertical and rocking impedance functions and on the contact stresses between the foundation and the soil are presented. The possibility of representing a flexible foundation by an equivalent rigid foundation having the same force-displacement relationships is also discussed. The results obtained indicate that at low frequencies, the dynamic stiffness coefficients for flexible foundations are lower than those for rigid foundations of the same area. At higher frequencies the opposite behavior is observed.

82-21

Dynamic Compliance Matrix of Rigid Strip Footing Bonded to a Viscoelastic Cross Anisotropic Half-space

G. Gazetas

Dept. of Civil Engrg., Case Inst. of Tech., Case Western Reserve Univ., Cleveland, OH, Intl. J. Mech. Sci., 23 (9), pp 547-559 (1981) 9 figs, 32 refs

Key Words: Footings, Interaction: structure-foundation, Interaction: soil-structure, Seismic excitation

The problem of determining the response of a rigid strip footing bonded to the surface of a viscoelastic cross-anisotropic halfspace is considered. The footing is subjected to vertical, shear and moment forces harmonically varying with time and uniformly distributed across the longitudinal axis,

so that plane strain conditions prevail. The solution is based on a transformation that uncouples the wave equations in closed-form and formulates the mixed boundary condition in terms of the Green's functions for the halfspace. Characteristic results, presented in the form of dynamic compliances as functions of frequency, demonstrate the importance of the degree of cross-anisotropy and of the internal soil damping on the response.

82-22

Frequency Independent Stiffness and Damping Coefficients for Structure-Foundation Systems

T. Balendra, Y.-P. Tan, and S.-L. Lee

Dept. of Civil Engrg., Natl. Univ. of Singapore, Singapore, China, Intl. J. Mech. Sci., 23 (9), pp 531-546 (1981) 15 figs, 2 tables, 23 refs

Key Words: Interaction: structure-foundation, Flexible foundations, Stiffness coefficients, Damping coefficients

Stiffness and damping coefficients for structure-foundation systems are obtained from transient analysis by conserving the average work done and the average rate of energy dissipation by the interaction forces. As the coefficients thus obtained are frequency independent, the structure-foundation system is represented by a simple model consisting of a set of frequency independent springs and dashpots in parallel for each mode of vibration.

82-23

Soil Structure Interaction: The Status of Current Analysis Methods and Research. Seismic Safety Margins Research Program

J.J. Johnson

Lawrence Livermore Natl. Lab., CA, Rept. No. UCRL-53011, 837 pp (Jan 1981)
NUREG/CR-1780

Key Words: Interaction: soil-structure, Foundations, Seismic response

Soil-structure interaction has been broadly reviewed by consulting engineers and members of the research community. The complexities of the phenomenon lead to the conclusion that the problem cannot be solved exactly. The problems of analysis include specifying the local free-field ground motion, adequately characterizing the configuration and properties of the soil, and modeling the foundations and structures of a nuclear power plant. Two analysis methods are available: the direct method, which analyzes the idealized soil-structure system in a single step, and the substructure approach, which treats the problem in a series of steps (determination of the foundation input motion, determination of the foundation impedances, and analysis of the coupled systems).

HARBORS AND DAMS

82-24

Dynamic Test of an Arch Dam Using a Laser Light Vibration Sensor

M. Corti, F. Parmigiani, and S.C.L. Botcherby

Centro Informazioni Studi Esperienze, Milan, Italy, Rept. No. CISE-1576, 11 pp (Sept 1980)
N81-20482

Key Words: Dams, Dynamic tests, Measuring instruments, Lasers

A laser light vibration sensor based on the Michelson interferometer principle is described. It operates with a 5 mW He-Ne laser source 200 m away from the moving target without the need of retroflective tools. Optimization of the electro-optic design reduces the effect of environmental disturbances and allows vibration amplitude resolution of 0.2 micrometers with flat response in the bandwidth 0.1 - 150 Hz. The laser beam is phase modulated by an electro-optic crystal. Modulation is required to sense the direction of target motion. The outgoing and returning light are compared in a Michelson interferometer.

82-25

Dynamic Analysis of an Arched Dam, Using Coherent Light Vibration Sensor (Analisi Dinamica di Una Diga AL Arco Mediante UN Sensore di Vibrazioni a Luce Coerente)

S.C.L. Botcherby, M. Corti, and F. Parmigiani

Centro Informazioni Studi Esperienze, Milan, Italy, Rept. No. CISE-1646, 10 pp (1980) (Presented at 2nd Natl. Congr. of Quantum and Plasma Electron., Palermo, Italy, May 20-22, 1980)
N81-22434
(In Italian)

Key Words: Measuring instruments, Vibration measurement, Lasers, Dams

A vibration sensor was developed using a 5 mW He-Ne laser in order to measure the dynamic characteristics of an arched

dam. The instrument is based on a Michelson polarization interferometer. The system has an amplitude resolution of one micron for measurements done at a distance of 200 m, for frequencies between 0.1 and 150 Hz. For narrow band signal analysis, the instrument has a resolution of 0.01 micron. These results were obtained by optimization of the electro optic system and by taking special precaution in reducing noise sources.

82-26

In Situ Seismic Investigation of Coyote Dam

R.E. Wahl, J.L. Llopis, and R.F. Ballard, Jr.

Geotechnical Lab., Army Engineer Waterways Experimental Station, Vicksburg, MS, Rept. No. WES/MP/GL-81-1, 53 pp (Mar 1981)
AD-A098 051/6

Key Words: Dams, Seismic response

An in situ seismic investigation consisting of surface refraction seismic, downhole, and crosshole tests was conducted at Coyote Dam, near Ukiah, California. Compression- and shear-wave (P- and S-wave) velocities as a function of depth were determined at two cross sections of the dam. P- and S-wave velocity profiles were also determined for the materials which comprise the left abutment.

ROADS AND TRACKS

82-27

Dynamic Response of Airfield Pavement to Large Magnitude Loads

G.A. Woelfl

Engrg. and Services Lab., Air Force Engrg. and Services Ctr., Tyndall AFB, FL, Rept. No. AFESC/ESL-TR-80-10, 34 pp (Jan 1980)
AD-A098 796

Key Words: Pavements, Runways, Concretes, Fatigue life

The evaluation of rapidly repaired bomb damage runways requires determining the dynamic response of pavement due to large dynamic loads. This report recommends using one of the sophisticated computer codes currently available for a conventional static analysis of airfield pavements, but with the use of appropriate dynamic material properties to predict the dynamic response of pavement. In order to select the appropriate dynamic material properties, the stress variation as a function of time is developed for pavements subjected to moving wheel loads.

CONSTRUCTION EQUIPMENT

82-28

Noise Control of Diesel-Powered Underground Mining Machines, 1979

J.H. Daniel, J.A. Burks, R.C. Bartholomae, R. Madden, and E.E. Ungar

Bolt, Beranek and Newman, Inc., Cambridge, MA, Rept. No. BUMINES-IC-8837, 35 pp (Mar 1981)
PB81-198020

Key Words: Mining equipment, Noise reduction

This Bureau of Mines report presents results of a survey of underground mining equipment and of two demonstration programs showing the feasibility of quieting a load-haul-dump (LHD) machine and a personnel vehicle. Typical noise levels are presented for the major machine types used in underground mines, along with estimates of the noise overexposure of miners who operate or work near these machines. General principles of noise control are explained, and the application of these principles is illustrated in the description of modifications made to the LHD machine and the personnel vehicle.

82-29

An Investigation of the Mechanics and Noise Associated with Coal Cutting

R.S. Becker, G.R. Anderson, II, and J. Kovac

Wyle Labs., Huntsville, AL, J. Engrg. Indus., Trans. ASME, 103 (3), pp 257-269 (Aug 1981) 15 figs, 16 refs

Key Words: Mining equipment, Mines (excavations), Noise generation, Noise reduction, Coal handling equipment

The results of a laboratory investigation of coal cutting mechanics and noise are presented. These experiments were performed using a linear cutting apparatus that operates over a broad cutting speed range. The influence of several coal cutting parameters on the noise, force, productivity, and specific energy associated with linear cuts was ascertained. Some basic theoretical aspects of coal cutting mechanics and noise generation are discussed, and the results of the laboratory experiments are used to formulate analytical models of the coal cutting forces and noise. The analytical

model for coal cutting noise is then generalized to account for the more important effects of rotary cutting. Based on the generalized model, an estimate of the sound pressure level at an operator's position is made for a typical continuous mining machine. It is concluded that by employing linear rather than rotary cuts, using deeper depths of cut, slower cutting speeds, and more efficient cutting tools, it is possible to reduce the level of coal cutting noise, as well as provide benefits to other important areas of health and safety in underground mining.

POWER PLANTS

(Also see Nos. 16, 87, 91, 200, 207, 209, 239)

82-30

State-of-the-Art Study Concerning Near-Field Earthquake Ground Motion

H.J. Swanger, S.M. Day, J.R. Murphy, and R. Guzman

Systems, Science and Software, La Jolla, CA, 155 pp (Mar 1981)
NUREG/CR-1978

Key Words: Nuclear power plants, Seismic design, Mathematical models

This report presents a summary of an investigation into the applicability of theoretical earthquake source modeling to the definition of design ground motion environments for nuclear power plants located in the near-field of potentially active faults. A variety of theoretical source models are examined to determine the characteristics of near-field ground motion predicted by such models and to isolate the sensitivities of high-frequency radiation characteristics to specific elements of the models. It is concluded that the high frequency ground motions predicted by the models are quite sensitive to particular details of implementation for which data and theory provide rather poor constraints. Examination of dynamic earthquake models suggests guidelines for extrapolation of model parameters to new stress-drops and magnitudes which are contrary to those procedures already in use.

82-31

Electric Power Plant Environmental Noise Guide

A.M. Teplitzky, T.J. Dubois, C.E. Hickman, R.C. Paladino, and M.A. Trykoski

Inst. of Noise Control Engrg., Arlington Branch, Poughkeepsie, NY, Noise Control Engrg., 16 (3), pp 138-144 (May-June 1981) 1 fig, 4 tables 19 refs

Key Words: Power plants (facilities), Noise reduction

Increasing concern by the utility industry over the impact assessment and abatement of power plant environmental noise emissions led to the formation of an environmental noise task force in 1975. This task force was charged with the development of a document which would serve as a single source guide for the prediction, evaluation, measurement and control of environmental noise emissions from existing and proposed electric utility power plants. The Electric Power Plant Environmental Noise Guide was made available to the utility industry and the public in early 1979. Basic objectives of the Guide, its usefulness to utility engineers and others interested in noise abatement, and the recommended methodology for predicting and assessing power plant environmental noise emissions are summarized.

82-32

CORTRAN Code User Manual

R.L. Cheatham, S.L. Crawford, and E.U. Khan

Battelle Pacific Northwest Labs., Richland, WA, 104 pp (Feb 1981)
PNL-3684

Key Words: Nuclear reactors, Transient excitation, Computer programs

CORTRAN has been developed as a relatively fast running design code for core-wide steady-state and transient analysis of Liquid Metal Fast Breeder Reactor cores. The preliminary version of this computer program uses subchannel analysis techniques to compute the velocity and temperature fields on a multiassembly basis for three types of transient forcing functions: total power, total flow, and inlet coolant temperature. Interassembly heat transfer, intra-assembly heat transfer, and intra-assembly flow redistribution due to buoyancy are taken into account. Heat generation within the fuel rods and assembly duct walls is also included.

OFF-SHORE STRUCTURES

(Also see No. 250)

82-33

Cyclic Inelastic Behavior of Steel Offshore Structures

V.A. Zayas, S.A. Mahin, and E.P. Popov

Earthquake Engrg. Res. Ctr., Univ. of California, Richmond, CA, Rept. No. UCB/EERC-80/27, 342 pp (Aug 1980)
PB81-196180

Key Words: Off-shore structures, Seismic response, Model testing, Experimental test data

Experimental results are presented on the cyclic inelastic behavior of two one-sixth scale frame models of a representative Southern California offshore platform designed according to American Petroleum Institute wave and earthquake criteria. The primary objective of the research effort is to improve the understanding of the behavior of braced structural systems subjected to damaging earthquake motions. The 29.5 ft. tall frame models consists of three braced panels which comprise a complete bent from the prototype X-braced platform.

VEHICLE SYSTEMS

GROUND VEHICLES

(Also see Nos. 159, 233)

82-34

A Comparison of the Automatic Shoulder Belt/Knee Bolster Restraint System with the Lap and Shoulder Belt System in VW Rabbits

G.Y.H. Chi and D.W. Reinfurt
Highway Safety Res. Ctr., North Carolina Univ. at Chapel Hill, Rept. No. DOT-HS-805 856, 123 pp (Mar 1981)
PB81-206286

Key Words: Collision research (automotive), Safety restraint systems, Seat belts

The objective of the research is to assess the injury reducing effectiveness of the VW Rabbit automatic shoulder belt/knee bolster system using statewide police-reported accident data. The analyses are aimed at answering questions about injury rate differences (manual vs automatic); restraint usage rate differences; performance differences between systems (when used); the proportion of injury rate reduction attributable to restraint usage rate differences; and adequacy of state accident data to carry out such investigations.

82-35

Results of Minicars RSV Crash Tests Conducted in France, Renault R20 TS-To Minicars RSV 75 Degree Left and Right Side Impacts

N. Johnson and S. Davis
Dynamic Science, Inc., Phoenix, AZ, Rept. No. 6079-80-200A, DOT-HS-805 771, 211 pp (Jan 1981)
PB81-184459

Key Words: Collision research (automotive)

The report presents the results of two side impact tests conducted on a Minicars RSV by Regie Nationale Des Usines Renault in France. Both tests consisted of 75 degree side impacts, one to the left side and one to the right side, of the stationary RSV. The bullet car in each test was a 1978 Renault R20TS Hatchback. The left side impact occurred at a speed of 31.2 mph and the right side impact at 40.5 mph. These crash tests evaluated the structural integrity and response of the Minicars RSV, and the dynamic response of its three dummy occupants in 75 degree side impact crashes.

82-36

Vehicle Crashworthiness and Aggressiveness. Volume I: Current Levels of Crashworthiness and Causes of Aggressiveness

T.F. MacLaughlin, R. Saul, and R.M. Morgan
Natl. Highway Traffic Safety Administration, Vehicle Res. and Test Ctr., East Liberty, OH, Rept. No. DOT-HS-805-712, 140 pp (Jan 1981)
PB81-166134

Key Words: Collision research (automotive), Crashworthiness, Experimental test data

Data from crash tests of current production vehicles were analyzed to determine their levels of crashworthiness, and to study causes of aggressiveness of large vehicles against smaller vehicles. In addition, results of crash tests conducted with a load cell barrier test device were analyzed to determine the suitability of the device for measuring vehicle aggressiveness. The analyses included mathematical modeling of vehicles, occupants and restraint systems, as well as evaluation of dummy response measurements. Results include presentation of frontal impact crashworthiness levels for different vehicle categories, recommendations regarding future testing and methods of analysis for side impact collisions, identification of the contributions of specific vehicle components toward frontal aggressiveness, and recommendations to further assess the ability of different types of crash barriers to measure aggressiveness for compliance with future safety standards.

82-37

Vehicle Crashworthiness and Aggressiveness. Volume II: Measurement of Aggressiveness for Safety Standards Compliance

T.F. MacLaughlin, R. Saul, and R.M. Morgan

Natl. Highway Traffic Safety Admin., Vehicle Res. and Test Ctr., East Liberty, OH, Rept. No. DOT-HS-805-713, 49 pp (Jan 1981)

PB81-166142

Key Words: Collision research (automotive), Crashworthiness, Experimental test data

Results of crash tests conducted with a load cell barrier test device (both moving and fixed) were analyzed in hopes of determining suitability of the device for future compliance test measurement of frontal vehicle aggressiveness. Responses of cars crashed against the load cell barrier were compared with responses against the standard fixed rigid barrier. In addition, an analytical study was performed to explore the capability of different types of barriers for measuring aggressiveness.

82-38

Response of Belted Dummy and Cadaver to Rear Impact

A.S. Hu and S.P. Bean

Physical Science Lab., New Mexico State Univ., Las Cruces, NM, Rept. No. PSL-PR00901, DOT-HS-805 792, 334 pp (Dec 1980)

PB81-191074

Key Words: Collision research (automotive), Anthropomorphic dummies, Cadavers, Automobile seat belts, Human response

Sled impact tests were conducted to simulate the motion of a standard size car at rest impacted from the rear by a second car of equal weight travelling at 32 mph. The test subjects were anthropomorphic dummies and unembalmed cadavers. They were seated in a bench seat and were unbelted. In one test mode the seatback was held rigid and in a second test mode the seatback rotated rearward in response to the test subject's impact loading. The major difference for either subject, between the rigid and the deflecting seatback mode was that the deflecting seatback reduced load force magnitude but increased time duration. Autopsies indicated that two of the three cadavers suffered neck injuries reaching AIS 3 scale while the third had no injury.

82-39

Vehicle Crashworthiness and Aggressiveness. Volume III: Appendices - Crash Pulses and Abag Computer Simulation

T.F. MacLaughlin, R. Saul, and R.M. Morgan

Vehicle Res. and Test Ctr., Natl. Highway Traffic Safety Admin., East Liberty, OH, Rept. No. DOT-HS-805-714, 173 pp (Jan 1981)

PB81-190589

Key Words: Collision research (automotive), Crashworthiness, Experimental test data

Data from crash tests of current production vehicles were analyzed to determine their levels of crashworthiness, and to study causes of aggressiveness of large vehicles against smaller vehicles. In addition, results of crash tests conducted with a load cell barrier test device were analyzed to determine the suitability of the device for measuring vehicle aggressiveness. The analyses included mathematical modeling of vehicles, occupants and restraint systems, as well as evaluation of dummy response measurements.

82-40

Effects of Tyres, Suspension, and Damping System of a Single Axle Caravan on the Directional Stability of the Combination Passenger Car/Caravan

W. Seibert and B. Breuer

Automobiltech. Z., 83 (6), pp 303-306 (June 1981)

9 figs, 6 refs

Key Words: Articulated vehicles, Trailers, Tires, Suspension systems (vehicles), Shock absorbers

Critical driving conditions may occur when towing caravans behind passenger cars as yaw movements are generated. The influence of the chassis of a single-axle-caravan on high speed stability is investigated. Alterations of tires, springs and shock absorbers in road tests as well as computer studies indicate the considerable contribution of the trailer chassis to driving safety. Further parameters of the trailer wheel suspension are being studied in experiments with an adjustable research chassis.

82-41

Motorcycle Aerodynamics in Performance

S.P.N.F. Jowitt and S.J. Kirby

Dept. of Aeronautical Engrg., Bristol Univ., UK, B.S. Thesis, Rept. No. BU-253, 74 pp (June 1980)
N81-20042

Key Words: Motorcycles, Aerodynamic characteristics, Wind tunnel tests, Model testing

Aerodynamic coefficients derived from force measurements on a 1/4 scale racing motorcycle in a wind tunnel are integrated into performance analyses to determine their influence. Measurements were made in yaw and roll, with the addition of strakes, and for motorcycles in proximity. The analyses considered were for steady state turning, straight line acceleration and straight line stability. Details of the flow field over the rider, from pressure measurements and visualization, show the existence of two vortices which contribute to drag, lift, and side force. A venturi effect occurs between the motorcycle fairing and ground plane as the motorcycle banks and is modulated by small rider movements. The addition of strakes to the flanks of the fairing has a negligible effect on cornering performance, but reduces the front wheel lift in accelerated motion. The model work is augmented with full scale examination of the rider flow in a wind tunnel and full scale visualization of the flow over the fairing to ensure correct model simulation.

82-42

Drivers Survey on Unreported and Low-Damage Accidents Involving Bumpers

J.S. Burke, D.M. Cadell, S.W. Huber, and D.R. Morganstein
Res. Div., Westat Inc., Rockville, MD, Rept. No. DOT-HS-805 838, 239 pp (Nov 1980)
PB81-189961

Key Words: Collision research (automotive), Bumpers, Energy absorption, Standards and codes

The study consisted of a national survey of drivers regarding low-speed, unreported accidents. Drivers were located using random digit dialing and then interviewed over the telephone. Drivers were asked about incidents occurring in the previous six months and then asked to participate in a re-interview two months later. The survey results indicate a substantial reduction in later model years in the percent of cars damaged, in the number of components damaged and in the cost of repair resulting from the low-speed incidents.

82-43

Analysis of Insurance Claims to Determine Bumper Effect on Crash Damage

P. Abramson, J. Cohen, and H. Stein
KLD Associates, Inc., Huntington, NY, Rept. No. COT-HS-805 842, 183 pp (Mar 1980)
PB81-188492

Key Words: Collision research (automotive), Bumpers, Energy absorption, Standards and codes

The effectiveness of the crash-protecting automobile bumpers required by Federal Motor Vehicle Safety Standard (FMVSS) 215 - Exterior Protection, Passenger Cars was evaluated through an analysis of insurance claims. FMVSS-215 was first implemented in 1973, requiring that bumpers meet certain minimum criteria during a 5-mph front barrier crash and a 2.5-mph rear barrier crash. In 1974, FMVSS-215 was expanded to require that bumpers meet minimum standards during corner pendulum crash tests as well. In addition, the barrier test was upgraded to 5-mph for the rear barrier crash. The current study compares accident claims from three periods: prior to enactment of FMVSS-215 (1972); the first year of the standards (1973); and additional years since upgrading of the standard (1974-78).

82-44

Analysis of Insurance Claims to Determine Bumper Effect on Crash Damage - 1979 Model Year, Addendum

P. Abramson, J. Cohen, and H. Stein
KLD Associates, Inc., Huntington, NY, Rept. No. DOT-HS-805 843, 55 pp (Oct 1980)
PB81-188500

Key Words: Collision research (automotive), Bumpers, Energy absorption, Standards and codes

The effectiveness of the crash-protecting automobile bumpers required by Part 581 - Bumper Standard, which replaced FMVSS-215 for vehicles manufactured after August 1978, was evaluated through an analysis of a sample of insurance claims. Part 581 Bumper Standard incorporates the safety-related performance criteria of FMVSS-215 and also specifies damage limitations to nonsafety-related components and the vehicle surface areas. The vehicle crash tests include longitudinal and corner pendulum impacts and front and rear barrier impacts (5 mph). The current study compared accident claims (frequency and cost) from four model year periods: prior to enactment of FMVSS-215 (1972); the combined experience of all previous vehicles complying with any version of the standard (1973-78); the combined experience of all previous vehicles complying with the upgraded version of the standard (1974-1978); and vehicles complying with Part 581 - Requirements (1979).

82-45

Off-Road Vehicle Dynamics

D.A. Cro...

Dept. of Mech. Engrg., The Univ. of Leeds, Leeds, UK, Vehicle Syst. Dyn., 10 (4-5), pp 253-266 (Sept 1981) 63 refs

Key Words: Off-highway vehicles, Tire characteristics, Tracked vehicles, Pneumatic tires, Ride dynamics

Recent developments in off-road vehicle dynamics are reviewed. Progress on this topic and the application of new techniques to the particular problems associated with off-road operation tend to lag behind practices established for road vehicles. The factor which limits further progress is the lack of appropriate off-road tire data, in particular, on vibrational and lateral force generation characteristics. Also, a long term study should be aimed at understanding the dynamic behavior of tires on yielding surfaces.

82-46

Vibration Level Data Brighton - New York City Transit Authority

E.J. Rickley and N.E. Rice

Transportation Systems Ctr., Cambridge, MA, Rept. No. DOT-TSC-UMTA-81-7, UMTA-MA-06-0099-81-2, 54 pp (Feb 1981)
PB81-202814

Key Words: Urban transportation, Transportation vehicles, Railroad trains, Vibration measurement, Experimental test data

This report documents the results of a vibration measurement program conducted on 14-15 August 1980 in the Midwood Section of Brooklyn, New York, next to the tracks of the Brighton Line of the New York City Transit Authority. The test was conducted by the Transportation Systems Center (TSC) for the Urban Mass Transportation Administration. The purpose of this test was to expand the data base being developed by the TSC for the prediction of ground-borne noise and vibration from nearby transit systems. A two-story home of a private citizen in Brooklyn was instrumented with six vibration transducers in several of the rooms and on the outside patio in order to obtain a measure of the ground and structural vibration levels resulting from the passby of rapid transit trains on the nearby tracks. This house was built on the old roadbed of the Long Island Railroad in 1943 and stands approximately 30 feet from the near track of the four-track right-of-way of the Brighton Line.

82-47

Fundamental Studies Related to Wheel-Rail Contact Stress

B. Paul

Dept. of Mech. Engrg. and Appl. Mechanics, Philadelphia Univ., Philadelphia, PA, Rept. No. FRA/ORD-81/05, 35 pp (Jan 1981)
PB81-194300

Key Words: Interaction: rail-wheel

This report summarizes the research performed and provides a brief review of the major results of the program. The problems discussed include the development of cost-effective methods for finding the wheel-rail contact patch, finding subsurface internal stresses, determining points where plastic flow will first occur, finding the distribution of surface shear stresses on the contact patch, finding the boundary between slip and adhesion on the contact patch, and finding the relationship between applied forces and wheel-rail creepage. This work will be useful in explaining and devising means of preventing various forms of stress-induced rail and wheel failures, as well as a whole complex of problems related to wheel-rail guidance and tractive forces. In particular, the dynamic behavior of rail vehicles can be analyzed relative to the forces developed at the rail-wheel interface.

82-48

Dynamic Interactions Between Travelling Vehicles and Guideway Systems

W. Kortüm and D.N. Wormley

Inst. for Dynamics of Flight Systems, DFVLR Oberpfaffenhofen, W. Germany, Vehicle Syst. Dyn., 10 (4-5), pp 285-317 (Sept 1981) 14 figs, 1 table, 100 refs

Key Words: Interaction: vehicle-guideway, Mathematical models, Simulation

The technical state-of-the-art of ground transportation vehicles interacting with flexible, perturbed guideway systems is reviewed with emphasis on high-speed passenger-carrying systems. Currently available modeling, analysis, and simulation techniques, as well as parametric results illustrating the dominant interaction dynamics, are summarized. Experimental studies and correlations of field data with analytical results are described and areas in which further research is required are identified.

82-49

Users' Manual for Linear Freight Car Forced Lateral Response Analysis Computer Program

N.K. Cooperrider and E.H. Law
Dept. of Mech. Engrg., Arizona State Univ., Tempe, AZ, Rept. No. FRA/ORD-80/85, 59 pp (Dec 1980) PB81-197410

Key Words: Railroad cars, Freight cars, Periodic response, Random response, Frequency domain method, Computer programs

This manual documents a Fortran IV computer program that solves for the forced lateral sinusoidal and random response of a linear, 9 degree-of-freedom freight car. The vehicle model represents the lateral dynamics of typical North American freight cars equipped with three piece trucks. Responses to both roadbed centerline alignment and cross level irregularities are computed. The response is calculated using frequency domain techniques. The steady state sinusoidal transfer functions are computed, response power spectral densities obtained and RMS values found by integration of the power spectra. Plots of selected output power spectra are prepared. The manual briefly describes the vehicle and roadbed model and the solution technique. The program description, a sample run and a complete program listing are included.

82-50
Wheel/Rail Noise Control - A Critical Evaluation
L.G. Kurzweil and L.E. Wittig
Bolt, Beranek and Newman, Inc., Cambridge, MA, Rept. No. DOT-TSC-UMTA-81-8, UMTA-MA-06-0099-81-1, 162 pp (Jan 1981) PB81-196859

Key Words: Railroad trains, Noise reduction, Interaction: rail-wheel

Noise and vibration are the major sources of environmental impact from urban rail transit operations, and is a concern for both new and existing systems. One of the primary sources of noise on rail transit systems is wheel/rail noise or the noise emitted by the wheels and rails as a result of their interaction. The purpose of this report is to carefully review and summarize the available information on each of the known or conceptualized methods for controlling wheel/rail noise and to identify requirements for further research, development, and testing. The report discusses the acoustical performance, costs, potential, or actual problems of these methods and suggestions are made for resolving uncertainties in the available data.

82-51
Railroad Car Coupling Shock, Vertical Motion, and Roller Bearing Temperature
T.V. Peacock and J.A. Richmond
Naval Surface Weapons Ctr., White Oak Lab., Silver Spring, MD, Rept. No. NSWC/WOL/TN-10592, DOT-TSC-FRA-81-4, FRA/ORD-81/13, 84 pp (Jan 1981) PB81-183469

Key Words: Railroad cars, Couplings, Impact shock

Data were collected in a study of railroad car operating environment. Measurements were made on wheel bearing operating temperatures, coupling impact shock, and vertical motion of the car due to rail travel.

SHIPS
(Also see No. 227)

82-52
Some Experimental Results with Ship Model Acceleration Waves
S.M. Çalişal
Naval Systems Engrg. Dept., Div. of Engrg. and Weapons, U.S. Naval Academy, Annapolis, MD, J. Ship Res., 25 (3), pp 181-190 (Sept 1981) 20 figs, 2 tables, 7 refs

Key Words: Ships, Water waves

The wave resistance of a ship moving at a constant speed can be calculated using information obtained from its wave pattern. One of the basic assumptions in wave survey methods is the existence of a time-independent model speed. In towing tanks initial acceleration is unavoidable. Wehausen showed that the effect of initial acceleration on wave resistance has a decaying and oscillating character. Çalişal gave the general form of the initial acceleration potential and showed the existence of a two-dimensional wave. To study the validity of the theoretical results, some experiments were performed. The variation of the measured spectra and the frequencies within the recorded total resistance pitching moment are of interest. Results indicate that models should travel a distance proportional to the square of the Froude number before wave data collection can begin, that the predicted encounter frequency exists in the recorded total resistance and pitching moment signals, and that special effort is required to avoid initial acceleration waves due to wall effects.

82-53
Acoustical Enclosures Control Ferry Boat Engine Noise

Diesel Progress North American, 47 (7), pp 36-37 (July 1981)

Key Words: Noise reduction, Ships

Noise reduction in engine control rooms aboard five motor vessels is described, by installing an enclosure whose layout would vary according to each boat's interior configuration. Readings show that the noise was reduced from over 100 dbA to 83 dbA.

AIRCRAFT

(Also see Nos. 79, 80, 88, 89, 90, 98, 155, 212, 249)

82-54

Airframe Noise of a Small Model Transport Aircraft and Scaling Effects

J.G. Shearin

NASA Langley Res. Ctr., Hampton, VA, Rept. No. NASA-TP-1858, L-14257, 27 pp (May 1981)
N81-22832

Key Words: Aircraft noise, Noise measurement, Scaling

Airframe noise of a 0.01 scale model Boeing 747 wide-body transport was measured. The model geometry simulated the landing and cruise configurations. The model noise was found to be similar in noise characteristics to that possessed by a 0.03 scale model 747. The 0.01 scale model noise data scaled to within 3 dB of full scale data using the same scaling relationships as that used to scale the 0.03 scale model noise data. The model noise data are compared with full scale noise data, where the full scale data are calculated using the NASA aircraft noise prediction program.

82-55

YC-14 Interior Noise Measurements Program

L.M. Butzel

Boeing Commercial Airplane Co., Seattle, WA, Rept. No. D748-10113-4, AFFDL-TR-77-128, 156 pp (Mar 1981)
AD-A098 799

Key Words: Aircraft noise, Interior noise, Noise measurement, Data processing

A test and preliminary analysis program was conducted to develop a data base and initial understanding of the interior noise of an Upper Surface Blowing STOL airplane using the YC-14 as a test vehicle. A data base has been secured consisting of concurrent cabin noise; exterior fuselage fluctuating pressures; fuselage wall vibrations; and associated aerodynamic, propulsive, and mechanical performance values covering the normal operating envelope of the airplane. Results from preliminary analysis of data show orderly and intuitively reasonable trends. The resultant data base is judged capable of supporting further detailed analysis.

82-56

YC-15 Interior Noise Measurements. Technical Discussion

J.L. Warnix and D.E. Hines

Douglas Aircraft Co., Long Beach, CA, Rept. No. MDC-J7191, AFFDL-TR-76-140, 124 pp (Mar 1981)
AD-A098 788

Key Words: Aircraft noise, Aircraft vibration, Interior noise, Noise measurement, Vibration measurement, Experimental test data

Tests were conducted to simultaneously measure exterior fuselage noise, structural vibration, and interior noise of a YC-15 advanced medium-range short-takeoff and landing transport airplane that employs an under-the-wing, externally-blown-flap powered lift system. The data obtained are of high quality and constitute a comprehensive data base of static ground tests at various flap and engine settings and flight tests at typical STOL takeoff, taxi, cruise, and landing.

82-57

Lateral Attenuation of High-by-Pass Ratio Engined Aircraft Noise

W.L. Willshire, Jr.

NASA Langley Res. Ctr., Hampton, VA, Rept. No. NASA-TM-81968, 38 pp (Apr 1981)
N81-23862

Key Words: Aircraft noise, Noise reduction

A flight experiment was conducted to investigate the lateral attenuation of high by pass ratio engined airplanes. A B-747 was flown at low altitudes over the ends of two microphone arrays. One array covering a lateral distance of 1600 m consisted of 14 microphones positioned over grass. The second array covered a lateral distance of 1200 m and consisted of 6 microphones positioned over a concrete runway. Sixteen runs were flown at altitudes ranging from 30 to 960 m. The acoustical information recorded in the field was reduced to

one third octave band spectral time histories and synchronized with tracking and weather information. Lateral attenuation as a function of elevation angle was calculated in overall, A-weighted, tone-corrected perceived noise level, and effective perceived noise level units. The B-747 results are compared with similar results for a turbojet-powered T-38 airplane and the SAE recommended lateral attenuation prediction procedure.

82-58

Flight and Wind-Tunnel Test Results of a Mechanical Jet Noise Suppressor Nozzle

R.D. FitzSimmons, R.A. McKinnon, and E.S. Johnson

Douglas Aircraft Co., McDonnell Douglas Corp., Long Beach, CA, J. Aircraft, 18 (9), pp 725-730 (Sept 1981) 16 figs, 19 refs

Key Words: Silencers, Aircraft noise, Supersonic aircraft, Wind tunnel tests, Flight tests

Comprehensive acoustics and propulsion data from tests of a mechanical jet noise suppressor designed to the requirements of a future supersonic transport is presented. Details from static, wind tunnel, and flight tests are presented illustrating forward-flight effects for correcting static acoustics and propulsion results. Flight test results are presented for a large scale mechanical suppressor/ejector model. The flight program was a joint effort by McDonnell Douglas, Rolls-Royce, Ltd., and the British Aerospace Corporation. The test aircraft had an uprated Viper engine providing pressure ratios approaching advanced supersonic transport engine designs. Results show the suppressor/treated ejector configuration provides a potential noise reduction at large scale of 16 EPNdB from that of the conventional conical nozzle at the highest pressure ratio tested (approximately 2.5).

82-59

Handbook of Aircraft Noise Metrics

R.L. Bennett and K.S. Pearsons

Bolt, Beranek and Newman, Inc., Canoga Park, CA, Rept. No. NASA-CR-3406, REPT-4215, 221 pp (Mar 1981)
N81-21871

Key Words: Aircraft noise, Noise measurement, Noise prediction

Information is presented on 22 noise metrics that are associated with the measurement and prediction of the effects of aircraft noise. Some of the instantaneous frequency weighted sound level measures, such as A-weighted sound level, are used to provide multiple assessment of the aircraft noise level. Other multiple event metrics, such as day-night average sound level, were designed to relate sound levels measured over a period of time to subjective responses in an effort to determine compatible land uses and aid in community planning.

82-60

Cumulative Annoyance Due to Multiple Aircraft Flyover with Differing Peak Noise Levels

K.P. Shepherd

Bionetics Corp., Hampton, VA, Rept. No. NASA-CR-3417, 30 pp (May 1981)
N81-23712

Key Words: Aircraft noise, Human response

A laboratory study in which 160 subjects judged the annoyance of 30 minute sessions of aircraft noise is described. Each session contained nine flyovers consisting of various combinations of three takeoff recordings of Boeing 727. The subjects were asked to judge their annoyance in the simulated living room environment of the laboratory and also to assess how annoyed they would be if they heard the noise in their home during the day, evening, and night periods. The standard deviation of the sound level did not improve the predictive ability of L sub eq (equivalent continuous sound level) which performed as well or better than other noise measured. Differences were found between the projected home responses for the day, evening, and nighttime periods. Time of day penalties derived from these results showed reasonable agreement with those currently used in community noise indices.

82-61

Airplane Wing Vibrations Due to Atmospheric Turbulence

R.L. Pastel, J.E. Caruthers, and W. Frost

Tennessee Univ. Space Inst., Tullahoma, TN, Rept. No. NASA-CR-3431, 84 pp (June 1981)
N81-24679

Key Words: Aircraft wings, Turbulence, Wind-induced excitation

The magnitude of error introduced due to wing vibration when measuring atmospheric turbulence with a wind probe

mounted at the wing tip was studied. It was also determined whether accelerometers mounted on the wing tip are needed to correct this error. A spectrum analysis approach is used to determine the error. Estimates of the B-57 wing characteristics are used to simulate the airplane wing, and von Karman's cross spectrum function is used to simulate atmospheric turbulence. It was found that wing vibration introduces large error in measured spectra of turbulence in the frequency's range close to the natural frequencies of the wing.

82-62

Transonic Flutter and Gust-Response Tests and Analyses of a Wind-Tunnel Model of a Torsion Free Wing Airplane

C.L. Ruhlin and A.C. Murphy
NASA Langley Res. Ctr., Hampton, VA, Rept. No. NASA-TM-81961, 17 pp (Apr 1981)
N81-23072

Key Words: Flutter, Aircraft, Wind-induced excitation, Wind tunnel tests, Model testing

An exploratory study of a 1/5.5 size, complete airplane version of a torsion free wing (TFW) fighter aircraft was conducted. The TFW consisted of a wing/boom/canard assembly on each fuselage side that was interconnected by a common pivot shaft so that the TFW could rotate freely in pitch. The effect of the TFW was evaluated by comparing data obtained with the TFW free and the TFW locked to the fuselage. With the model mounted on cables to simulate an airplane free flying condition, flutter boundaries were measured at Mach number (M) from 0.85 to 1.0 and gust responses at M = 0.85 and 0.90. The critical flutter mode for the TFW free configuration was found experimentally to occur at M = 0.95 and had the rigid TFW pitch mode as its apparent aerodynamic driver.

82-63

Experimental and Analytical Study on the Flutter and Gust Response Characteristics of a Torsion-Free Wing Airplane Model

A.C. Murphy
General Dynamics, Fort Worth, TX, Rept. No. NASA-CR-159283, 145 pp (Mar 1981)
N81-21059

Key Words: Flutter, Aircraft, Wind-induced excitation

Experimental data and correlative analytical results on the flutter and gust response characteristics of a torsion-free-wing (TFW) fighter airplane model are presented. TFW consists of a combined wing/boom/canard surface and was tested with the TFW free to pivot in pitch and with the TFW locked to the fuselage. Flutter and gust response characteristics were measured in the Langley Transonic Dynamics Tunnel with the complete airplane model mounted on a cable mount system that provided a near free flying condition. Although the lowest flutter dynamic pressure was measured for the wing free configuration, it was only about 20 degrees less than that for the wing locked configuration. However, no appreciable alleviation of the gust response was measured by freeing the wing.

82-64

Transonic Flutter Study of a Wind-Tunnel Model of an Arrow-Wing Supersonic Transport

C.L. Ruhlin and C.R. Pratt-barlow
NASA Langley Res. Ctr., Hampton, VA, Rept. No. NASA-TM-81962, 16 pp (Apr 1981)
N81-23071

Key Words: Flutter, Aircraft, Wind tunnel tests, Model testing

A 1/20-size, low-speed flutter model of the SCAT-15F complete airplane was tested on cables to simulate a near free-flying condition. Only the model wing and fuselage were flexible. Flutter boundaries were measured for a nominal configuration and a configuration with wing fins removed at Mach numbers M from 0.76 to 1.2. For both configurations, the transonic dip in the wing flutter dynamic pressure q boundary was relatively small and the minimum flutter q occurred near M = 0.92. Removing the wing fins increased the flutter q about 14 percent and changed the flutter mode from symmetric to antisymmetric. Vibration and flutter analyses were made using a finite-element structural representation and subsonic kernel-function aerodynamics.

82-65

Aircraft Ground Dynamics

H.P.Y. Hitch
Weybridge-Bristol Div., British Aerospace Public Limited Co., Weybridge, Surrey, UK, Vehicle Syst. Dyn., 10 (4-5), pp 319-332 (Sept 1981) 14 figs

Key Words: Aircraft, Landing gear, Taxiing effects

The state-of-the-art in analyzing a number of ground maneuvering processes on aircraft is described. The mathematical models are as good as the data supplied to them.

82-66

Sources, Control, and Effects of Noise from Aircraft Propellers and Rotors

J.S. Mixson, G.C. Greene, and T.K. Dempsey
NASA Langley Res. Ctr., Hampton, VA, Rept. No. NASA-TM-81971, L-14468, 25 pp (Apr 1981)
N81-21904

Key Words: Aircraft noise, Helicopter noise, Noise source identification, Noise reduction

Recent NASA and NASA sponsored research on the prediction and control of propeller and rotor source noise, on the analysis and design of fuselage sidewall noise control treatments, and on the measurement and quantification of the response of passengers to aircraft noise is described. Source noise predictions are compared with measurements for conventional low speed propellers, for new high speed propellers (propfans), and for a helicopter. Results from a light aircraft demonstration program are considered which indicates that about 5 dB reduction of flyover noise can be obtained without significant performance penalty. Sidewall design studies are examined for interior noise control in light general aviation aircraft and in large transports using propfan propulsion.

82-67

The Background and Bases for the Proposed Military Standard on Acoustical Noise Limits in Helicopters

G.R. Garinther and D.C. Hodge
Human Engrg. Lab., Aberdeen Proving Ground, MD, Rept. No. HEL-TM-5-81, 13 pp (Mar 1981)
AD-A099 814

Key Words: Helicopters, Interior noise, Human response, Standards and codes

A design standard for interior noise of helicopters has been prepared to provide the developer and user with realistic noise limits which consider hearing damage risk, speech intelligibility, mission profile, state-of-the-art in noise reduction, and helicopter weight. The levels selected meet the current hearing conservation limits of the Department of Defense and permit electrically aided sentence intelligibility of 98%. Helicopters below 20,000 pounds are treated separately from those above because of the strong positive relation between internal noise and vehicle gross weight. This standard defines the locations and flight conditions under which noise measurements shall be made for compliance. It also specifies the types of instrumentation and the test procedures to be used to collect interior noise level data.

82-68

Flight Test Evaluation of a Nonlinear Hub Spring on a UH-1H Helicopter

P.J. Hollifield, L.W. Dooley, J.R. Van Gaasbeek, J.D. Honaker, and J. Carr
Bell Helicopter Textron, Fort Worth, TX, Rept. No. USAAVRADCOM-TR-80-D-27, 159 pp (Apr 1981)
AD-A098 794

Key Words: Helicopters, Rotors, Springs, Stability, Flight tests, Computer programs

A nonlinear hub spring design and results of the subsequent flight testing as a concept to provide increased mast bumping safety margin for the UH-1H helicopter is presented. Although there is a need for additional testing, the hub spring is shown to provide an increased margin of safety by reducing main rotor flapping in all conditions tested. As a part of this effort, a hybrid computer program was verified as able to predict mast loads due to flapping stop contact. Using this program a parametric study of mast loads as a function of rotor flapping was performed in order to develop a design criteria to ensure that mast loads can be sustained during in-flight flapping stop contact. In addition, a comparison of the main rotor flapping predicted by the hybrid computer and the digital computer C81 program using elastic blades is shown. Also, an evaluation of US Army helicopter tactics to determine which NOE maneuvers are susceptible to high main rotor flapping is presented.

82-69

Study of Oscillatory and Flight Dynamic Behavior of Helicopters in Atmospheric Turbulence

H. Dahl and D. Weger
Messerschmitt-Boelkow-Blohm GmbH, Munich, Germany, Rept. No. BMVG-FBWT-80-4, 72 pp (1980)
N81-21074

Key Words: Helicopters, Propeller blades, Wind-induced excitation, Turbulence

A statistical model was developed which takes the nonuniform nature of the gust velocity distribution into account together with the dynamic transient oscillation of the rotor blades. Because gust effects depend strongly on the helicopter's control behavior, an analytic pilot function is included in the considerations. Hingeless and hinged rotor systems are compared. Physiological factors and data acquisition are also discussed. The results enable gust reduction systems to be incorporated in the design of helicopters.

82-70

Subjective Field Study of Response to Impulsive Helicopter Noise

C.A. Powell

NASA Langley Res. Ctr., Hampton, VA, Rept. No. NASA-TP-1833, L-14205, 43 pp (Apr 1981)
N81-21873

Key Words: Helicopter noise, Human response

Subjects, located outdoors and indoors, judged the noisiness and other subjective noise characteristics of flyovers of two helicopters and a propeller driven airplane as part of a study of the effects of impulsiveness on the subjective response to helicopter noise. In the first experiment, the impulsive characteristics of one helicopter was controlled by varying the main rotor speed while maintaining a constant airspeed in level flight. The second experiment which utilized only the helicopters, included descent and level flight operations. The more impulsive helicopter was consistently judged less noisy than the less impulsive helicopter at equal effective perceived noise levels (EPNL). The ability of EPNL to predict noisiness was not improved by the addition of either of two proposed impulse corrections. A subjective measure of impulsiveness, however, which was not significantly related to the proposed impulse corrections, was found to improve the predictive ability of EPNL.

82-71

Comparison of Predicted Engine Core Noise with Proposed FAA Helicopter Noise Certification Requirements

U. Vonglahn and D. Groesbeck

NASA Lewis Res. Ctr., Cleveland, OH, Rept. No. NASA-TM-81739, E-791, 19 pp (1981)
N81-22839

Key Words: Helicopter noise Engine noise, Noise measurement, Noise prediction

Calculated engine core noise levels, based on NASA-Lewis prediction procedures, for five representative helicopter engines are compared with measured total helicopter noise levels and proposed FAA helicopter noise certification requirements. Comparisons are made for level flyover and approach procedures. The measured noise levels are generally significantly greater than those predicted for the core noise levels, except for Sikorsky S-61 and S-64 helicopters. However, the predicted engine core noise levels are generally at or within 3 db of the proposed FAA noise rules. Consequently, helicopter engine core noise can be a significant contributor to the overall helicopter noise signature and, at this time, will provide a limiting floor to a further decrease in future noise regulations.

82-72

An Extension of the Local Momentum Theory to a Distorted Wake Model of a Hovering Rotor

K. Kawachi

NASA Ames Res. Ctr., Moffett Field, CA, Rept. No. NASA-TM-81258, A-8436, 112 pp (Feb 1981)
N81-20030

Key Words: Helicopters, Rotors, Propeller blades

The local momentum theory is based on the instantaneous balance between the fluid momentum and the blade elemental lift at a local station in the rotor rotational plane. Therefore, the theory has the capability of evaluating time wise variations of air loading and induced velocity distributions along a helicopter blade span. Unlike a complex vortex theory, this theory was developed to analyze the instantaneous induced velocity distribution effectively. The boundaries of this theory and a computer program using this theory are discussed. A concept introduced into the theory is the effect of the rotor wake contraction in hovering flight. A comparison of this extended local momentum theory with a prescribed wake vortex theory is also presented. The results indicate that the extended local momentum theory has the capability of achieving a level of accuracy similar to that of the prescribed wake vortex theory over wide range variations of rotor geometrical parameters. It is also shown that the analytical results obtained using either theory are in reasonable agreement with experimental data.

MISSILES AND SPACECRAFT

82-73

A Comparison of Damping Synthesis Methods for Space Vehicle Dynamic Analysis

E. Maddah and J.F. Imbert

Centre National d'Etudes Spatiales, Toulouse, France, Rept. No. CNES-80/CT/PRT/SST/SM/316, 22 pp (Oct 1, 1980)
N81-20171

Key Words: Spacecraft, Substructuring methods, Structural synthesis, Damping coefficients

Substructure coupling methods for dynamic analysis are compared, emphasizing damping synthesis methods which obtain the damping characteristics of a structure from component damping test data. A variant of the modal substitution method is considered which uses component eigencharacteristics with either free or loaded interface for the main component, and fixed for branches. Also examined is the free interface method with residual flexibility. Implementation of both methods for specific cases was performed

using the NASTRAN DMAP capability. Numerical comparisons of sample test cases was carried out, using a free-free beam example, a mass-spring dashpot system, and the viscosity damped Benfield truss. This evaluation confirms the importance of the interface loading in the model substitution method and the addition of residual flexibility in free-free methods.

82-74
Viscoelastic Propellant Effects on Space Shuttle Dynamics
F. Bugg
NASA, George C. Marshall Space Flight Ctr., Huntsville, AL, Rept. No. NASA-TM-82403, 22 pp (Mar 1981)
N81-20289

Key Words: Spacecraft, Space shuttles, Propellants, Viscoelastic properties

The program of solid propellant research performed in support of the space shuttle dynamics modeling effort is described. Stiffness, damping, and compressibility of the propellant and the effects of many variables on these properties are discussed. The relationship between the propellant and solid rocket booster dynamics during liftoff and boost flight conditions and the effects of booster vibration and propellant stiffness on free-free solid rocket booster modes are described. Coupled modes of the shuttle system and the effect of propellant stiffness on the interfaces of the booster and the external tank are described. A finite shell model of the solid rocket booster was developed.

BIOLOGICAL SYSTEMS

HUMAN
(Also see No. 38)

82-75
The Economics of Industrial Noise Control in Australia
D.C. Gibson and M.P. Norton
Commonwealth Scientific and Industrial Res. Organization, Highett, Victoria, Australia 3190, Noise Control Engrg., 16 (3), pp 126-135 (May-June 1981) 6 figs, 7 tables, 28 refs

Key Words: Noise reduction, Noise tolerance, Human response

Important sources of industrial noise and the level of exposure of workers to noise in Australian industry are examined. The magnitude of the noise problem is estimated in terms of its social and economic consequences. The annual cost of meeting workers compensation claims for hearing impairment is found to be marginally more than the equivalent cost of mounting hearing protection programs. Noise reduction costs per worker are greater than compensation costs per worker; therefore, in the absence of restrictions on operation, there is no apparent financial incentive for Australian industry to reduce its noise.

82-76
Estimates of Annoyance of Sounds of Different Character
B.L. Cardozo and R.A.J.M. van Lieshout
Instituut voor Perceptic Onderzoek, Den Doleck, Eindhoven, The Netherlands, Appl. Acoust., 14 (5), pp 323-329 (Sept-Oct 1981) 1 fig, 3 tables, 4 refs

Key Words: Noise tolerance, Human response

The character of a sound is defined as the weighted combination of all acoustic factors, not contained in L_A, contributing to its annoyance. From this definition it follows that differences in annoyance due to sounds with equal L_A are differences in sound character. For the concept of sound character to have real significance it is necessary that listeners agree on the annoyance due to sounds with equal L_A. This paper describes a listening experiment with a variety of sounds of equal L_A. The annoyance due to the sounds was rated by twelve subjects. Their individual ratings show significant agreement.

82-77
Annoyance Caused by Light Aircraft Noise
NASA, Washington, DC, Rept. No. NASA-TM-76533, 134 pp (Mar 1981) (Engl. transl. of "Stoerwirkungen durch den Laerm der Kleinaviatik," Switzerland, June 1980, pp 1-132)
N81-22589

Key Words: Aircraft noise, Human response

The correlation between objective and noise stresses and subjectively perceived disturbance from general aviation

aircraft was studied at six Swiss airports. Noise levels calculated for these airports are given. Survey results are analyzed.

82-78

The Annoyance Caused by Airplane Noise in the Vicinity of Orly Airport and the Reaction of Neighboring Residents

J. Francois

NASA, Washington, DC, Rept. No. NASA-TM-76575, 16 pp (Apr 1981) (Engl. transl. of "La Gene Causee Par le Bruit des Avions au Voisinage de l'Aeroport d'Orly et les Reactions des Riverains," Paris, Aug 1972, 15 pp)

N81-22590

Key Words: Airports, Aircraft noise, Human response

General conclusions and the technical appendix of a report on the attitudes of people living near Orly Airport (Paris) toward airplane noise are presented. The noise was found to be very disruptive of residents' lifestyle and well being, although differences in perceived nuisance were noted. The factors inducing people to protest and who they blame for the present situation are discussed. It was found that the public image of protestors was generally positive and that people who did not protest were viewed as passive, uncaring, or else connected to aviation.

82-79

The Status of Airport Noise Prediction, with Special Reference to the United Kingdom and Europe

J.B. Large and M.E. House

Inst. Sound Vib. Res., Univ. of Southampton, Southampton, UK, Noise Control Engrg., 17 (1), pp 38-44 (July-Aug 1981) 4 figs, 3 tables, 12 refs

Key Words: Airports, Aircraft noise, Noise prediction

The current capability to predict noise reaching communities from all phases of airport activity is examined and the methodologies for contour calculation and assessment are briefly outlined. Areas for further study and refinement of procedures are indicated. In particular, the need for greater accuracy is highlighted in assessments made for legislative/statutory purposes. The evolving importance of noise sources on the ground, which are increasing alongside airport development, is emphasized.

82-80

An Airport Community Noise-Impact Assessment Model

R. Deloach

NASA Langley Res. Ctr., Hampton, VA, Rept. No. NASA-TM-80198, 21 pp (July 1980) (Presented at the 98th ASA Mtg., Salt Lake City, Utah, Nov 26-30, 1979)

N81-23713

Key Words: Airports, Aircraft noise, Mathematical models

A computer model was developed to assess the noise impact of an airport on the community which it serves. Assessments are made using the fractional impact method by which a single number describes the community aircraft noise environment in terms of exposed population and multiple event noise level. The model is comprised of three elements: a conventional noise footprint model, a site specific population distribution model, and a dose response transfer function.

82-81

The Effect of Airplane Noise on the Inhabitants of Areas Near Okecie Airport in Warsaw

Z. Koszarny, S. Maziarka, and W. Szata

NASA, Washington, DC, Rept. No. NASA-TM-75879, 9 pp (May 1981) (Engl. transl. from Rocznik Panstwowego Zakladu Hygieny (Poland), V. 27, No. 2, 1976, pp 113-121)

N81-22593

Key Words: Airports, Aircraft noise, Human response

The state of health and noise annoyance among persons living in areas near Okecie airport exposed to various intensities of noise was evaluated. Very high annoyance effects of airplane noise of intensities over 100 dB(A) were established. A connection between the airplane noise and certain ailments complained about by the inhabitants was demonstrated.

82-82

The Relationship Between Noise and Annoyance Around Orly

J. Francois and J.P. Roche

NASA, Washington, DC, Rept. No. NASA-TM-76573, 90 pp (May 1981) (Engl. transl. of "Liaison Dentre

le Bruit et la Gene Autour d'Orly," Paris, Jan 1973, 76 pp)
N81-22594

Key Words: Airports, Aircraft noise, Human response

The extent to which annoyance estimated by an isopsophic index is a good forecaster for annoyance perceived near airport approaches was investigated. An index of sensed annoyance is constructed, and the relationship between the annoyance index and the isopsophic index is studied.

82-83

Biodynamic Response to Whole-Body Vibration

M.J. Griffin

Human Factors Res. Unit, Inst. Sound Vib. Res., Univ. of Southampton, Southampton, UK, Shock Vib. Dig., 13 (8), pp 3-12 (Aug 1981) 6 figs, 47 refs

Key Words: Vibration excitation, Human response, Reviews

Recent experimental studies of biodynamic response to vibration and some attempts to model this response are reviewed. It is proposed that biodynamic models should be classified according to their general application. It is shown that the responses of the body to vibration are highly varied and there is a need for increased availability of experimental biodynamic data.

82-84

Vibration Comfort in Suburban Buses (Schwingungskomfort in Nahverkehrs-Ominbussen)

D. Buhr

Hamburger Kamp, 5B 2000 Oststeinbek, Hamburg, Germany, Automobiltech. Z., 83 (7/8), pp 365-368 (July/Aug 1981) 7 figs, 3 refs
(In German)

Key Words: Buses, Vibration excitation, Human response

At the IVA '79 in Hamburg the new citybus S 80 and the new intercity bus U 80 were presented. In these buses comfort was measured with regard to vertical vibrations. The results of both tests are compared with the one of the common city bus VOV I. The above mentioned comfort in the new citybus S 80 is about the same as in the present VOV I. They are both equipped with air spring suspension. In contrast to these, the intercity bus U 80 has a hydro-pneumatic spring suspension. In the intercity bus half the amount of vertical accelerations existed compared to the city buses. Measurements proved that in all these types of buses the best comfort is in the middle and the most uncomfortable place is in the rearmost row of seats.

82-85

Hypothesis on Simultaneous Noise-and-Vibration Annoyance Rating in Shipboard Accommodation

J.H. Janssen

TPD, Inst. of Appl. Physics, Postbus 155, 2600 AD Delft, The Netherlands, Noise Control Engrg., 16 (3), pp 145-150 (May-June 1981) 6 figs, 8 refs

Key Words: Ships, Ship vibration, Noise generation, Human response

Passengers and crew on board sea-going ships rate noise and vibration as one coherent agent affecting their proficiency and satisfaction. Ship vibration annoyance problems cannot be tackled adequately without considering the simultaneous noise, and vice versa. The author based a hypothesis of a vibration rating scale matched to the ISO/R 1996 noise rating scale on data available in TPD files obtained from measurements of vibration and noise in eleven motorships where "noise-and-vibration juries" expressed 65 annoyance judgments on simple category scales.

82-86

Vibration in a Helmet Mounted Sight (HMS) Using Mechanical Linkage

J.C. Johnson, D.B. Priser, and R.W. Verona

Army Aeromedical Res. Lab., Fort Rucker, AL, Rept. No. USAARL-81-3, 30 pp (Mar 1981)
AD-A098 533

Key Words: Aircraft vibration, Helmets, Human response

The purpose of this experiment was to determine the extent to which aircraft vibration was coupled to a crewman's flight helmet by the mechanical linkage of a helmet mounted sight. Two variations of the SPH-4 flight helmet were tested: SPH-4 with standard web suspension and SPH-4 with a form-fit foam liner suspension. The system was tested in the front seat of an AH-1S Cobra helicopter. Five flight conditions were used in the experiment.

MECHANICAL COMPONENTS

ABSORBERS AND ISOLATORS

(Also see Nos. 42, 43, 44)

82-87

Testing of a Natural Rubber Base Isolation System by an Explosively Simulated Earthquake

J.M. Kelly

Earthquake Engrg. Res. Ctr., Univ. of California, Richmond, CA, Rept. No. UCB/EERC-80/25, 60 pp (Aug 1980)

PB81-201360

Key Words: Isolators, Seismic isolation, Elastomers, Experimental test data, Containment structures, Model testing

This report describes the base isolation experiment of the SIMQUAKE II test. The experiment used a 1/24-scale model of a containment structure. The model was mounted on a base isolation system which incorporated multilayer natural rubber bearings and a fail-safe system of novel design. The base isolation system was designed to produce a very low natural frequency of vibration in horizontal motion and much higher natural frequencies for the vertical and rocking motions. During the SIMQUAKE II experiment the isolation system was subjected to two distinct ground motions.

82-88

An Operations Manual for the Spinning Mode Synthesizer in the Langley Aircraft Noise Reduction Laboratory

D.L. Palumbo

Kentron International, Inc., Hampton, VA, Rept. No. NASA-CR-165698, 50 pp (Mar 1981)

N81-22835

Key Words: Aircraft noise, Noise reduction

The need for a dependable and controllable noise source and the consequent development of the Spinning Mode Synthesizer (SMS) is discussed. Configuration of the SMS incorporated into the flow duct facility is reported. Turbofan noise is composed of a series of fundamental acoustical modes, which are produced by acoustic drivers equispaced circumferentially around the flow duct. Pressure field is compared to an ideal result in an optimization algorithm, adjusting driver settings until system error is minimized. The following items are included: operating instructions, a detailed description of the system, and a user's guide to data acquisition packages available.

82-89

Compensating Linkage for Main Rotor Control

P.A.E. Jeffery and R.F. Huber

Nasa Langley Res. Ctr., Hampton, VA, PATENT-4 245 956, 6 pp (Jan 20, 1981)

Key Words: Isolators, Linkages, Helicopters, Rotors, Airframes

A compensating linkage for the rotor control system on rotary wing aircraft is described. The main rotor and transmission are isolated from the airframe structure by elastic suspension. The compensating linkage prevents unwanted signal inputs to the rotor control system caused by relative motion of the airframe structure and the main rotor and transmission.

82-90

Total Main Rotor Isolation System Analysis

V. Sankewitsch

Boeing Vertol Co., Philadelphia, PA, Rept. No. NASA-CR-165666, D-210-11788-1, 82 pp (Mar 1981)

N81-20027

Key Words: Isolators, Helicopters, Rotors

Requirements, preliminary design, and verification procedures for a total main rotor isolation system at n/rev are presented. The fuselage is isolated from the vibration inducing main rotor at one frequency in all degrees of freedom by four antiresonant isolation units. Effects of parametric variations on isolation system performance are evaluated.

82-91

Control of Seismic Response of Piping Systems and Other Structures by Base Isolation

J.M. Kelly

Earthquake Engrg. Res. Ctr., Univ. of California, Richmond, CA, Rept. No. UCB/EERC-81/01, 90 pp

(Jan 1981) (Papers presented at Century 2 – Emerging Technology Conferences, San Francisco, CA, Aug 10-21, 1980)
PB81-200735

Key Words: Isolators, Seismic isolation, Power plants (facilities), Piping systems, Elastomeric bearings

This report contains four papers on aseismic base isolation in power plants and other structures, presented at the Emerging Technology Conferences. The following aspects of base isolation are considered: the historic development of base isolation; design of multilayer rubber bearings; performance of flexibly mounted equipment; and the Alexisismon isolation system comprising connecting elements which are horizontally positioned steel bars the middle section of which ruptures during a severe earthquake, and supporting elements which are elastomeric bearings combined with pot bearings.

82-92

Railway Vehicle Active Suspensions

J.K. Hedrick

Dept. of Mech. Engrg., Massachusetts Inst. of Tech., Cambridge, MA, Vehicle Syst. Dyn., 10 (4-5), pp 267-283 (Sept 1981) 10 figs, 1 table, 25 refs

Key Words: Active isolation, Suspension systems (vehicles), Railroad trains

The state-of-the-art of active suspensions for use on railway vehicles is reviewed. The primary focus of the paper is on ride quality control, both vertical and lateral, and on lateral stability control. The section on theoretical considerations summarizes the results of a one-degree of freedom optimization and then investigates analytically the use of active suspensions for lateral ride and stability augmentation. It is shown that separate control structures using different measurements and actuator actions are very effective in controlling both ride quality and stability. A section on a survey of current activities reviews published research on active railway suspension work around the world.

82-93

Vibrational Isolation of Large Scale Finite Element Models Using Optimization

W.V. Nack

Aerospace Engrg. Dept., Embry Riddle Aeronautical Univ., Daytona Beach, FL, Computers Struc., 14 (1-2), pp 149-152 (1981) 4 tables, 20 refs

Key Words: Vibration isolation, Finite element technique, Optimization, Harmonic response, Random response

An optimization system has been developed to minimize the forced vibrational response of large scale finite element models by adjusting isolator elements. The technique can be applied to models under steady state harmonic response and stationary random response. This will automate the design process for vibrational isolation, and the algorithms are expected to solve numerous practical problems.

82-94

Sound Transfer via Resilient Mounts from Separate Excitation with Orthogonal Translations and Rotations: Development and Test of a Measurement Technique

Y.W. Yerheij

Technisch Physische Dienst TNO-TH, Delft, The Netherlands, Rept. No. TNO-908.835, 60 pp (Jan 11, 1980)
N81-24867

Key Words: Sound transmission, Mountings, Equipment mounts, Shipboard machinery, Measurement techniques, Stiffness coefficients

The measurement of the sound transmission properties of resilient mounts for machinery in ships is considered. A measurement method is presented which determines five transfer functions related to the compressive, transverse, torsional and bending stiffness of a mount. The method of measurement is part of a procedure which enables an accurate analysis of those factors which limit the effectiveness of a resilient mounting system with respect to the reduction of noise radiation into the water. Special attention is given to the separation of excitation by transverse accelerations and that by a rotation on a horizontal axis.

82-95

On the Structural Formation of Concrete Steel Components Subject to Earthquake Stress

R. Sitka

Ph.D. Thesis, Technische Hochschule, Darmstadt, Germany, 128 pp (1980)
PB81-183543
(In German)

Key Words: Energy absorption, Buildings, Earthquake response, Structural members, Steel, Concretes

Plastic form change work to partially absorb the energy transferred to a building in earthquake regions necessitates both an appropriate carrying system and careful shaping of the individual structural components. The existing ductility is utilized by only using fractions of the actual ground acceleration or comparatively high damping values. Associated reduction factors are determined by comparing work on the elastic and elastic-plastic stiffening system. A review is presented on the behavior of steel and concrete from the elastic boundary to fracture together with measures to improve plastic formability.

82-96

Working of Magnetic Dynamic Absorber (Optimal Damping of M.D. with a Viscous Damper)

Y. Kurakake, Y. Hara, and S. Fukuda

Sasebo Technical College, Sasebo-City, Nagasaki, Japan, Bull. JSME, 24 (193), pp 1239-1246 (July 1981) 7 figs, 6 refs

Key Words: Absorbers (equipment), Dynamic absorbers, Magnetic damping, Viscous damping

A dynamic absorber which contains two fixed side magnets, and an absorber magnet (absorber mass) is called a magnetic dynamic absorber (M.D.). The absorber magnet is located between the side magnets and floats along the axis between them, each working on the other's magnetic forces. As the vibrating system (principal mass) is attached on a damped magnetic dynamic absorber and subjected to an external periodic force, the amplitude of the principal mass can be decreased. In this paper the vertical and horizontal vibrations of a periodically forced vibration system with M.D. are analyzed. The most favorable state in the principal mass which is worked by M.D. is discussed and the values of its amplitude in the most favorable state are solved. The absorber factors of M.D. which depend on the condition are obtained and are compared with the experimental results.

82-97

Device for Absorbing Mechanical Shock

C.E. Newlon

Dept. of Energy, Washington, DC, U.S. PATENT-4 241 810

Key Words: Shock absorbers, Elastomers, Energy absorption, Cylinders

This invention is a comparatively inexpensive but efficient shock-absorbing device having special application to the protection of shipping and storage cylinders. In a typical application, two of the devices are strapped to a cylinder to serve as saddle-type supports for the cylinder during storage and to protect the cylinder in the event it is dropped during lifting or lowering operations. In its preferred form the invention includes a hardwood plank whose grain is in the longitudinal direction. The basal portion of the plank is of solid cross-section, whereas the upper surface of the plank is cut away to form a concave surface fittable against the sidewall of a storage cylinder. The concave surface is divided into a series of segments by transversely extending, throughgoing relief slots. A layer of elastomeric material is positioned on the concave face, the elastomer being extrudable into slots when pressed against the segments by a preselected pressure characteristic of a high-energy impact.

TIRES AND WHEELS

(Also see No. 45)

82-98

Static and Dynamic Evaluation of A-37 Cast and Cast Carcass/Integral Tread Tires

P.C. Ulrich

Air Force Wright Aeronautical Labs., Wright-Patterson AFB, OH, Rept. No. AFWAL-TR-80-3055, 326 pp (Nov 1980)

AD-A097 684

Key Words: Tires, Aircraft tires, Dynamic tests

This report describes work undertaken during Phases II and III of a three phase program to establish the potential of cast tires for application to Air Force aircraft. Phases II and III involved static, quasi-static, and dynamic laboratory test and evaluation of 30 cast 7.00-8 Type III aircraft tire designs. These designs included tire carcasses which were rotationally cast/molded from thermoplastic polyester elastomer materials of various hardness with and without reinforcements. Three basic cast tire designs were developed and evaluated during Phase II efforts. Twenty-five integral tire design iterations (105 tires), some of which included glass reinforcement, were tested and evaluated to the A-37 aircraft main gear tire specifications.

82-99

Static and Yawed-Rolling Mechanical Properties of Two Type 7 Aircraft Tires

J.A. Tanner, S.M. Stubbs, and J.L. McCarty

NASA Langley Res. Ctr., Hampton, VA, Rept. No.

NASA-TP-1863, L-14125, 80 pp (May 1981)
N81-24471

Key Words: Aircraft tires, Tires, Tire characteristics

Selected mechanical properties of type 7 aircraft tires were evaluated. The tires were subjected to pure vertical loads and to combined vertical and lateral loads under both static and rolling conditions. Parameters for the static tests consisted of tire load in the vertical and lateral directions, and parameters for the rolling tests included tire vertical load, yaw angle, and ground speed. Effects of each of these parameters on the measured tire characteristics are discussed and, where possible, compared with previous work. Results indicate that dynamic tire properties under investigation were generally insensitive to speed variations and therefore tend to support the conclusion that many tire dynamic characteristics can be obtained from static and low speed rolling tests.

82-100

In-Plane and Out-of-Plane Dynamics of Pneumatic Tyres

H.B.Pacejka

Delft Univ. of Tech., The Netherlands, Vehicle Syst. Dyn., 10 (4-5), pp 221-251 (Sept 1981) 14 figs, 28 refs

Key Words: Tires, Pneumatic tires, Lateral response, Longitudinal response

During the last decade research has been conducted on the dynamics of the tire considered as a vehicle component. A survey is given of these developments where tire mass plays an important role. The underlying theoretical considerations concerning the massless tire are discussed. Two groups of tire response are distinguished: the lateral (out-of-plane) response and the vertical/longitudinal (in-plane) response to motions of the wheel. In both categories tire compliance, slip and inertia have influence. The dynamic properties of the rolling tire are presented in the form of transfer functions and/or differential equations.

BLADES

(Also see No. 5)

82-101

Coupled Bending-Bending Vibrations of Pre-Twisted Cantilever Blading Allowing for Shear Deflection and Rotary Inertia by the Reissner Method

K.B. Subrahmanyam and S.V. Kulkarni

Dept. of Mech. Engrg., Regional Engrg. College, Kurukshetra, India, Intl. J. Mech. Sci., 23 (9), pp 517-530 (1981) 9 figs, 3 tables, 27 refs

Key Words: Blades, Cantilever beams, Flexural vibration, Transverse shear deformation effects, Rotatory inertia effects, Reissner method, Natural frequencies, Mode shapes

The Reissner method and the total potential energy approach are applied to a pre-twisted cantilever blade executing coupled bending-bending vibrations. Shear deflection and rotary inertia are accounted for in the analysis and the natural frequencies and mode shapes of the first four coupled modes are determined. A comparison of the results obtained from this investigation with those available in the literature indicates that the Reissner method gives quicker convergence and better mode shapes than the potential energy method and it is further seen that the inclusion of shear deflection and rotary inertia into the analysis leads to a reduction in the frequency values, thus resulting in a closer agreement with experimental results.

82-102

Long Arc Shrouding - A Reliability Improvement for Untuned Steam Turbine Blading

R.J. Ortolano, J.A. La Rosa, and W.P. Welch

Engrg. and Construction Dept., Southern California Edison Co., Rosemead, CA, J. Engrg. Power, Trans. ASME, 103 (3), pp 522-531 (July 1981) 9 figs, 3 tables, 7 refs

Key Words: Blades, Turbine blades, Steam turbines, Fatigue life, Shrouds

An approach to the design and modification of untuned variable speed steam turbine exhaust blading has been found to be highly successful in eliminating fatigue failures due to the first tangential in-phase mode resonance. The approach consists of butt-welding the shrouds on the short arc blade groups to form a substantially longer arc length. The result is a significant reduction in vibratory stress at resonant speeds.

BEARINGS

(Also see Nos. 2, 4, 204)

82-103

NASA Five-Ball Fatigue Tester: Over 20 Years of Research

E.V. Zaretsky, R.J. Parker, and W.J. Anderson

NASA Lewis Res. Ctr., Cleveland, OH, Rept. No. NASA-TM-82589, E-720, 57 pp (1981) (Presented at the Intl. Symp. on Contact Rolling Fatigue Testing of Bearing Steel, Phoenix, AZ, May 12-14, 1981; Sponsored by ASTM)
N81-23462

Key Words: Bearings, Rolling contact bearings, Fatigue life

Studies were conducted to determine the effect on rolling-element fatigue life of contact angle, material hardness, chemistry, heat treatment and processing, lubricant type and chemistry, elastohydrodynamic film thickness, deformation and wear, vacuum, and temperature as well as Hertzian and residual stresses. Correlation was established between the results obtained using the five-ball tester and those obtained with full scale rolling-element bearings.

82-104
Unbalance Response of a Two-Spool Gas Turbine Engine with Squeeze Film Bearings

E.J. Gunter, L.E. Barrett, and D.F. Li
Univ. of Virginia, Charlottesville, VA, ASME Paper No. 81-GT-219

Key Words: Squeeze film bearings, Bearings, Rotors, Turbine engines, Unbalanced mass response

This paper presents a dynamic analysis of a two-spool gas turbine helicopter engine incorporating intershaft rolling element bearings between the gas generator and power turbine rotors. The analysis includes the nonlinear effects of a squeeze film bearing incorporated on the gas generator rotor. It was found that large intershaft bearing forces may occur even though the engine is not operating at a resonant condition.

82-105
Life Analysis of Multiroller Planetary Traction Drive

J.J. Coy, D.A. Rohn, and S.H. Loewenthal
NASA Lewis Res. Ctr., Cleveland, OH, Rept. No. NASA-TP-1710, AVRADCOM-TR-80-C-16, 16 pp (Apr 1981)
N81-20423

Key Words: Mechanical drives, Bearings, Rolling contact bearings, Fatigue life

A contact fatigue life analysis was performed for a constant ratio, Nasvytis multiroller traction drive. The analysis was based on the Lundberg-Palmgren method for rolling element bearing life prediction. Life adjustment factors for materials, processing, lubrication and traction were included.

82-106
Laboratory Investigation of Water-Lubricated Elastomeric Bearings

R.L. Smith, A.I. Krauter, and C.H.T. Pan
Shaker Res. Corp., Ballston Lake, NY, Rept. No. SRC-80-TR-64, 40 pp (Jan 1981)
AD-A097 109

Key Words: Bearings, Friction bearings, Plain bearings, Friction

This report concerns an experimental laboratory study of the sliding friction behavior of water-lubricated rubber stave bearings. Speed dependent friction characteristics were measured because they are associated with the phenomenon of audible self-excited vibrations. As part of an effort to establish guidance for the design of noise-free stern tube bearings, the friction-speed curves for five modified designs were obtained and were compared with those for a conventional design.

82-107
Analysis and Simulation of a Magnetic Bearing Suspension System for a Laboratory Model Annular Momentum Control Device

N.J. Groom, C.T. Woolley, and S.M. Joshi
NASA Langley Res. Ctr., Hampton, VA, Rept. No. NASA-TP-1799, L-12403, 38 pp (Mar 1981)
N81-20311

Key Words: Bearings, Magnetic bearings

A linear analysis and the results of a nonlinear simulation of a magnetic bearing suspension system which uses permanent magnet flux biasing are presented. The simulation includes rigid body rim dynamics, linear and nonlinear axial actuators, linear radial actuators, axial and radial rim warp, and power supply and power drive current limits.

82-108
Stabilized Bearings with Finite-Element Analysis

J.C. Nicholas

Ingersoll-Rand Co., Phillipsburg, NJ, Machine Des., 53 (16), pp 169-170 (July 9, 1981)

Key Words: Bearings, Design techniques, Finite element technique

Optimum design of stabilized stepped pocket bearing using finite element method is presented. An example illustrates that when axial groove bearings were removed and modified with optimized stepped pockets the vibration was suppressed, and the units operate free of high-vibration trip-outs.

82-109

Dynamic Characteristics of a High-Speed Rotor with Radial and Axial Foil-Bearing Supports

L. Licht, W.J. Anderson, and S.W. Doroff

J. Lubric. Tech., Trans. ASME, 103 (3), pp 361-372 (July 1981) 15 figs, 15 refs

Key Words: Bearings, Foil bearings, Rotors

An asymmetric rotor, supported radially and axially by compliant bearings (foil bearings), is subjected to severe excitation by rotating unbalance in the pitching mode at speeds to 50,000 rpm. The resilient, air-lubricated bearings provide very effective damping, so that regions of resonance and instability can be traversed with impunity, with amplitudes and limit-trajectories remaining within acceptable bounds. A novel journal bearing is introduced, in which a resilient support is furnished by the outer turn of the coiled foil-element, initially bent to form an open polygon. The experimental apparatus and procedure are described, and the response of the rotor and flexible support system are copiously documented by oscilloscope records of motion.

COUPLINGS

82-110

The Effects of Torsional Vibration

P.D. Zubritsky

American Vulkan, Winter Haven, FL, Diesel Progress, 47 (7), pp 31-34 (July 1981)

Key Words: Vibration control, Torsional vibration, Couplings

The elements in a diesel engine system that can cause vibration are varied. The role of couplings in reducing system vibration and the methodology used in isolating the source of vibration and the effect of proper component selection are discussed in this article. While the specific example concerns a marine system, the data can be applied to any engine-driven system.

FASTENERS

(Also see No. 117)

82-111

Low-Cycle Fatigue Resistance of Welded Joints of Cr Mo and 20 Mn 5 Steels (Odolnosť zvarových spojov ocelí Cr Mo a 20 Mn 5 pri nízkocyklovej únave)

V. Gregor

Welding Res. Inst., Bratislava, Czechoslovakia, Strojinicky Časopis, 32 (3), pp 367-375 (1981) 4 figs, 4 tables, 5 refs

(In Slovak)

Key Words: Fatigue life, Steel, Joints (junctions), Welded joints

The results of a study of low-cycle fatigue and crack growth characteristics in the steels and welded joints suitable for construction of pressure vessels are analyzed. The fatigue crack growth was studied on the specimens for low-cycle fatigue tests and the obtained characteristics of the fatigue crack growth were applied in calculation of the residual life.

LINKAGES

(See No. 89)

SEALS

82-112

Spring and Damping Coefficients of the Labyrinth Seals

M. Kurohashi, Y. Inoue, T. Abe, and T. Fujikawa Graduate School of Engrg., Kobe Univ., UK, Vibrations in Rotating Machinery, Proc. 2nd Intl. Conf., Churchill College, Cambridge, UK, Sept 1-4, 1980, organized by Instn. Mech. Engrs., pp 215-222, 16 figs, 9 refs

Key Words: Seals, Damping coefficients, Spring constants

The expressions for calculating the spring and damping coefficients of Labyrinth seals are derived with the simple

explicit forms considering the change of flow coefficient and the several assumptions which seem appropriate. The expressions are on principal and cross coupling terms which contain the rotating speed, the pressure of entrance and exit side, the change of gap clearance of labyrinth along the rotor axis and the density of fluid. The calculation results of the derived expressions show good accord with the results of detailed analysis. Results of the expressions qualitatively agree with the experimental data.

STRUCTURAL COMPONENTS

STRINGS AND ROPES

82-113
Dynamic Behaviour of Unsymmetric Stiffened Strings
G.M. Faulkner, A. Mioduchowski, and J.S. Kennedy
Dept. of Mech. Engrg., Univ. of Alberta, Edmonton, Alberta, Canada, Strojnicky Casopis, 32 (1), pp 23-33 (1981) 6 figs, 7 refs

Key Words: Strings, Stiffened structures, Natural frequencies, Periodic excitation, Runge-Kutta method

The dynamic problem for unsymmetric stiffened lines is considered in this paper. The basic equations for both the static and the dynamic condition are developed. The equations for the dynamic condition are solved for both stiffened and unstiffened lines using a fourth order Runge-Kutta integration technique. Plots of dimensionless frequency versus the range to length of line ratio are given with the dimensionless weight per unit length of line as a parameter.

CABLES

82-114
A Curved Element for the Analysis of Cable Structures
H.B. Jayaraman and W.C. Knudson
Structural Engrg. Res. Ctr., Roorkee, India, Computers Struc., 14 (3-4), pp 325-333 (1981) 11 figs, 5 tables, 19 refs

Key Words: Cables (ropes), Finite element technique

A small strain elastic catenary element is presented and its utility is demonstrated through static and dynamic cable problems. Its accuracy and efficiency are found to be comparable or better to some of the elements presented in the literature. Cables that are initially curved or that assume a curved shape as a result of deformation can be modeled using the proposed element. Self-weight of the cables can be included without any approximations. Prestress in the element can also be included. The element program developed can readily be used with the currently available nonlinear codes like Newton-Raphson method.

BARS AND RODS

82-115
Out-plane Vibrations of Curved Bars Considering Shear Deformation and Rotatory Inertia
K. Suzuki and S. Takahashi
Faculty of Engrg., Yamagata Univ., Yonezawa, Japan, Bull. JSME, 24 (193), pp 1206-1213 (July 1981) 8 figs, 10 refs

Key Words: Bars, Curved beams, Vibration response, Transverse shear deformation effects, Rotatory inertia effects

A method is given for solving the free out-plane vibrations of a uniform curved bar of which the center line is a plane curve considering the effects of the bending, the torsion, the shear deformation and the rotatory inertia of the bar. Equations of vibration are solved exactly by a series solution. As numerical examples, natural frequencies and mode shapes of symmetric catenary, parabola and cycloid curved bars with clamped ends are obtained. The numerical results by the present analysis are compared with the ones by the classical theory and the effects of the shear deformation and the rotatory inertia are clarified.

82-116
Similarity Analysis of Wave Propagation Problems in Nonlinear Rods
R. Seshadri and M.C. Singh
Syncrude Canada Ltd., Edmonton, Alberta, Canada, Arch. Mechanics, 32 (6), pp 933-945 (1980) 5 figs, 8 refs

Key Words: Rods, Wave propagation

Similarity analysis of wave propagation problems in nonlinear rods are discussed from the viewpoint of continuous groups of transformations. For the governing nonlinear partial differential equations, the similarity variables and the charac-

teristics of the equation are related at the wave front. A procedure leading to a similarity-characteristic relationship is developed which provides an additional condition at the wave front for the solution of the similarity representation. The similarity-characteristic relationship is derived for the problem of velocity impact of an inelastic rod and solutions for the wave propagation problem are obtained.

BEAMS

(Also see Nos. 10, 240)

82-117

Theoretical and Experimental Investigations of Structureborne Sound Transmission through a "T" Joint in a Finite System

G. Rosenhouse, H. Ertel, and F.P. Mechel
Fraunhofer-Institut für Bauphysik, Königsträssle, Stuttgart, Germany, J. Acoust. Soc. Amer., 70 (2), pp 492-499 (Aug 1981) 8 figs, 5 tables, 6 refs

Key Words: Beams, T-beams, Joints (junctions), Sound transmission

The wave theory approach was used for analysis of sound transmission through a "T" joint in a finite system consisting of rectangular beams. The analytical results were confirmed by experiments. A comparison of the sound transmission through a "T" joint in finite and infinite systems revealed completely different behavior. Various kinds of joints including a welded "T," a "T" connected by screws, and a "T" incorporating a rubber layer were examined. Comparisons between the analytical and experimental results of structureborne sound transmission through the various joints showed that the analytical treatment developed is applicable for all types of "T" junctions described above.

82-118

Summed and Differential Harmonic Oscillations in a Slender Beam

T. Yamamoto, K. Yasuda, and N. Tei
Faculty of Engrg., Nagoya Univ., Chikusaku, Nagoya, Japan, Bull. JSME, 24 (193), pp 1214-1222 (July 1981) 9 figs, 14 refs

Key Words: Beams, Harmonic excitation, Sum and difference frequencies, Harmonic response

Various types of nonlinear forced oscillations are expected to occur in a beam subjected to harmonic excitation. This paper is concerned with the summed and differential harmonic oscillations. Theoretical as well as experimental analyses are carried out for the oscillations. The theoretical analysis shows that only the summed type can occur in a beam, and that a constant term is necessary in the excitation for the oscillations to occur. The theoretical analysis also reveals that the transition to the state in which only the harmonic oscillation occurs, is made continuously by increasing the excitation frequency. The experimental analysis verifies the results of the theoretical analysis.

82-119

Transient Responses of the Timoshenko Beam Evaluated by the Double Laplace Transform

E. Huntley and A.S.I. Zinober
Dept. of Appl. and Computational Mathematics, Univ. of Sheffield, Sheffield, UK, Computers Struc., 14 (3-4), pp 319-323 (1981) 6 figs, 17 refs

Key Words: Beams, Timoshenko theory, Transient response, Frequency response, Laplace transformation

Double Laplace transform (DLT) theory has been applied to the evaluation of transient responses and frequency responses of a semi-infinite Timoshenko beam. DLT expressions for the various response variables are established and a numerical DLT inversion algorithm is employed to give the temporal and spatial responses. The results are shown to be very accurate. A wide variety of time-varying loads and boundary conditions can be easily handled by the one approach. The conceptual and practical simplicity of the method is demonstrated and extensions to more complex problems are indicated.

82-120

Subharmonic Oscillations of a Slender Beam

T. Yamamoto, K. Yasuda, and K. Aoki
Nagoya Univ., Furocho, Chikusa, Nagoya, Japan, Bull. JSME, 24 (192), pp 1011-1020 (June 1981) 10 figs, 11 refs

Key Words: Beams, Subharmonic oscillations, Harmonic excitation

Various types of nonlinear steady forced vibrations are expected to occur in a beam subjected to harmonic excitation. This paper is concerned with the subharmonic oscillations of order 1/2 and of order 1/3. Theoretical analysis is carried out by assuming the deflection as a superposition of linear mode shapes. The theoretical analysis proves the occurrence

of the subharmonic oscillations. For a subharmonic oscillation of order 1/2 to occur, a constant term is necessary in the excitation. The transition to the state in which this oscillation occurs from the state in which only a harmonic oscillation occurs, is made continuously by increasing the excitation frequency. For a subharmonic oscillation of order 1/3, the constant term is not necessary. The transition to the state in which this oscillation occurs cannot be made by varying the excitation frequency. The experimental results confirm the results of the theoretical analysis.

82-121

Transverse-Vibration Responses of Nonuniform, Internally Damped Cantilever Beams. II

R.L. Kerlin

Appl. Res. Lab., Pennsylvania State Univ., University Park, PA, J. Acoust. Soc. Amer., 70 (2), pp 481-491 (Aug 1981) 8 figs, 3 tables, 12 refs

Key Words: Beams, Cantilever beams, Flexural vibration

The Bernoulli-Euler theory of transverse beam vibration, suitably extended to take into account internal beam damping, is used to derive closed-form expressions for the mechanical driving-point impedance and force transmissibility of two types of nonuniform cantilever beams that are driven at their free ends by a sinusoidally varying point force. The two types of beams considered are (1) truncated and of rectangular cross section with a linearly tapered depth and a breadth appropriately varied (hyperbolically) to maintain constant cross-sectional area, and (2) composed of three stages, each of which is uniform but may vary arbitrarily from the others in cross section and proportionate length. Representative computations of the frequency dependence of impedance and transmissibility are plotted for beams having the same length and mass as an equally long and equally massive uniform reference beam. Significant attenuation or amplification of force transmissibility is observed, depending on the proportions of the beams and on whether their depth diminishes towards their fixed or free end.

82-122

On the Stability of a Composite Beam with Initial Stress to Moving Loads

B. Prasad

Engrg. and Res. Staff, Metallurgy Dept., Ford Motor Co., Dearborn, MI, J. Appl. Mechanics, Trans. ASME, 48 (2), pp 368-370 (June 1981) 3 figs, 6 refs

Key Words: Beams, Composite beams, Moving loads, Bernoulli-Euler method

Analytical expressions of the critical velocity as a function of initial axial stress and foundation modulus parameters are derived for the composite beam. Critical velocities are also obtained on the basis of Bernoulli-Euler beam equations and the results compared.

COLUMNS

82-123

Experimental Study of Small-Scale R/C Columns Subjected to Axial and Shear Force Reversals

N.D. Gilbertsen and J.P. Moehle

Dept. of Civil Engrg., Univ. of Illinois at Urbana-Champaign, IL, Rept. No. UILU-ENG-80-2015, STRUCTURAL RESEARCH SER-481, NSF/RA-800495, 104 pp (July 1980)
PB81-192767

Key Words: Columns, Reinforced concrete, Dynamic tests, Experimental test data, Model testing, Hysteretic damping, Fracture properties

Reinforced concrete (R/C) columns were subjected to a series of shear force or simultaneous shear and axial force reversals. The test specimens were similar to the first story columns of model structures designed to investigate dynamic response of R/C structures. Models consisted of nine-story, three-bay frames of approximately one-twelfth scale. Test variables included the reinforcement ratio, the dead load on the column, and the rate of axial load variation during shear force reversals. Behavior of the specimens was represented by measured hysteresis relations and crack patterns. The observed behavior was compared with the calculated response. Many graphs and tables illustrate the text.

FRAMES AND ARCHES

(Also see No. 234)

82-124

Seismic Damage in Reinforced Concrete Frames

H. Banon, J.M. Biggs, and H.M. Irvine

Struct. Mechanics Associates, Newport Beach, CA, ASCE J. Struc. Div., 107 (9), pp 1713-1729 (Sept 1981) 9 figs, 2 tables, 21 refs

Key Words: Frames, Concretes, Reinforced concrete, Damage prediction, Seismic excitation

Damage prediction for reinforced concrete (RC) frames is usually measured in terms of ductility demands for beams and columns. In order to develop a more rigorous model of member damage in RC frames, other damage parameters are introduced, and their effectiveness in prediction of damage is tested. Laboratory tests of RC members and subassemblages are used to check the accuracy of both mechanical models and damage parameters. Reinforced concrete members, when subjected to cyclic inelastic deformations, exhibit both stiffness and strength degradation.

PLATES

(Also see Nos. 10, 151)

82-125

A Note to Free Bending Modes of Vibrations of a Rectangular Sandwich Plate (Poznámka k priečnym vlastným kmitom obdĺžnikovej sendvičovej dosky)

S. Markuš and O. Daněk
Inst. of Machine Mechanics of the Slovak Academy of Sciences, Bratislava, Czechoslovakia, Strojnicky Casopis, 32 (1), pp 65-77 (1981) 3 figs, 5 tables, 6 refs
(In Slovak)

Key Words: Plates, Rectangular plates, Sandwich structures, Natural frequencies

An in-plane inertia parameter M is defined and it is shown how this parameter influences values of natural frequencies of sandwich plates. The impact of parameter M is illustrated on a rectangular plate. The refined values are compared with those obtained by Mead.

82-126

On the Mode of Instability of a Simply Supported Rectangular Plate Subjected to Follower Forces

H.H.E. Leipholz and D. Waddington
Dept. of Civil Engrg., Univ. of Waterloo, Ontario, Canada, Mechanics Res. Comm., 8 (4), pp 223-229 (1981) 6 figs

Key Words: Plates, Rectangular plates, Follower forces, Flutter

In previous investigations the simply supported rectangular plate subjected to uniformly distributed follower forces of intensity q turned out to be a divergence system for the particular aspect ratio then chosen. In this paper, it is investigated whether the mode of instability could change from divergence to flutter for other aspect ratios.

82-127

Plate Vibration Research, 1976-1980: Classical Theory

A.W. Leissa
Boyd Lab., Ohio State Univ., Columbus, OH, Shock Vib. Dig., 13 (9), pp 11-22 (Sept 1981) 2 figs, 1 table, 110 refs

Key Words: Plates, Flexural vibration

This paper is the first of two summarizing recent research in free, transverse vibrations of plates. The present paper deals with problems governed by the classical theory of plates; i.e., homogeneous, isotropic, thin, constant thickness, no inplane initial forces, small transverse displacements, vibrating in a vacuum, etc.

82-128

Nonlinear Vibration of Layered Composite Plates Including Transverse Shear and Rotatory Inertia

J.N. Reddy
Dept. of Engrg. Science and Mechanics, Virginia Polytechnic Inst. and State Univ., Blacksburg, VA, Rept. No. VPI-E-81.6, 27 pp (Mar 1981)
PB81-183642

Key Words: Plates, Layered materials, Flexural vibration, Transverse shear deformation effects, Rotatory inertia effects

The large amplitude free flexural vibration of layered composite plates, incorporating the effects of transverse shear and rotatory inertia, is studied using a finite element based on the displacement field of a shear deformable theory and the strain-displacement equations of von Karman's plate theory. Free vibration of cross-ply and angle-ply rectangular plates is analyzed and natural frequencies are presented showing the effects of boundary conditions, side-to-thickness ratio (i.e., transverse shear), aspect ratio, orientation of layers and material anisotropy.

82-129

Estimation of Noise Emitted by Vibration of a Plate

N. Kojima, K. Kioma, and M. Fukuda

Faculty of Engrg., Yamaguchi Univ., Tokiwadai, Ube, Japan, Bull. JSME, 24 (193), pp 1233-1238 (July 1981) 9 figs, 3 tables, 7 refs

Key Words: Plates, Vibration excitation, Noise generation

On a running machine, the band frequency components of vibration at each portion of the external surfaces are classified into two categories. One is a stationary component and the other is a non-stationary one. This paper describes an approach to estimation of the noise emitted by each of them. In the former case, assuming that the vibrating plate consists of many minute elements and each of them vibrates in a simple harmonic motion, the sound pressure levels can be estimated by summing up all the sound pressures radiated from each minute source. In the latter case, the radiation efficiency which is defined as a coupling coefficient between surface vibration and radiated acoustic power can be calculated as a function of density, thickness and stiffness of each plate. The acoustic power levels estimated by using this radiation efficiency and the mean square average of vibration acceleration have been found to be in good agreement with those obtained from the experiment.

82-130

Transverse Shear and Rotatory Inertia Effects on Nonlinear Vibration of Orthotropic Circular Plates

M. Sathyamoorthy

Dept. of Mech. and Indust. Engrg., Clarkson College of Tech., Potsdam, NY, Computers Struc., 14 (1-2), pp 129-134 (1981) 5 figs, 3 tables, 11 refs

Key Words: Plates, Circular plates, Orthotropism, Transverse shear deformation effects, Rotatory inertia effects

A nonlinear vibration theory which includes the effects of transverse shear deformation and rotatory inertia is formulated for orthotropic circular plates using the Berger approximation. Solutions to the governing equations are obtained on the basis of a single-mode approach by use of Galerkin's method and numerical Runge-Kutta procedure. Results indicate significant influence of these effects on the nonlinear vibration behavior of orthotropic circular plates. Present results are in good agreement with those available in the literature for all special cases. It is observed that there is a substantial saving in the analytical and computational efforts in using the Berger approach and that this approach yields reasonably good results comparable with those obtained by the corresponding von Karman type theory.

82-131

Static and Dynamic Analysis of Thin and Thick Sectorial Plates by the Finite Strip Method

M.S. Cheung and M.Y.T. Chan

Public Works Canada, Ottawa, Ontario, Canada, Computers Struc., 14 (1-2), pp 79-88 (1981) 4 figs, 7 tables, 15 refs

Key Words: Plates, Finite strip method

Two and three-dimensional finite strips are developed for the analysis of thin and thick sectorial plates. The plates can be isotropic or orthotropic, of constant or variable thickness, and can have different combinations of boundary conditions. The displacement functions for the finite strips are made up of polynomial shape functions and beam eigenfunctions. The 2-D finite strips are derived based on plate bending theory and have as nodal degrees of freedom, the out-of-plane displacement and the slope. The 3-D finite strips are formulated using three-dimensional elasticity constitutive equations, and the three displacement components in a cylindrical co-ordinate system are chosen as the nodal degrees of freedom. Numerical results involving various boundary conditions, radii and subtended angles are presented. Comparisons are made with existing solutions whenever available. Close agreements are noted.

82-132

Structural Response and Input Identification

G.D. Shepard, J.C. Callahan, and J.A. Mcelman

Lowell Univ., MA, Rept. No. NASA-CR-164079, 108 pp (Mar 27, 1981)

N81-20465

Key Words: Plates, Random excitation, Acoustic excitation

Three major goals were delineated: to develop a general method for determining the response of a structure to combined base and acoustic random excitation; to develop parametric relationships to aid in the design of plates which are subjected to random force or random base excitation; to develop a method to identify the individual acoustic and base input to a structure with only a limited number of measurement channels, when both types of excitation act simultaneously.

82-133

A Finite-Element Analysis of Bimodulus Composite Plates and Shells

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Dept. of Engrg. Science and Mechanics, Virginia Polytechnic Inst. and State Univ., Blacksburg, VA,

Rept. No. VPI-E-81-7, 17 pp (Mar 1981) (Paper for pres. at the Intl. Congress on the Application of Mathematics in Engrg. (9th), June 28 - July 5, 1981, Weimar, Germany, G.C.)
PB81-191686

Key Words: Plates, Shells, Composite structures, Vibration analysis, Finite element technique

The literature available in English on bending and vibration analyses of bimodulus plates is quite sparse and largely concerned with the bending of bimodulus isotropic-material plates. In the previous papers by the author and his colleagues, closed-form and finite-element results were reported for simply-supported plates and shells subjected sinusoidally distributed loadings. The present paper reports finite-element solutions for other boundary conditions and loadings which do not admit closed-form solutions.

SHELLS

(Also see No. 133)

82-134
Studies of Dynamic and Static Response of Cylindrical Liquid-Storage Tanks

A. Kumar
Ph.D. Thesis, Rice Univ., 198 pp (1981)
UM 8116972

Key Words: Shells, Cylindrical shells, Storage tanks, Fluid-filled containers, Base excitation

This study deals with the following two aspects of the response of liquid-filled cylindrical elastic tanks: dynamic response to a vertical excitation of the base; and statical analysis under antisymmetrical forces of the type obtained in analyses of the dynamic response of the tank to a lateral excitation.

82-135
A Seismic Response Analysis of a Cylindrical Liquid Storage Tank

K. Fujita
Takasago Technical Inst., Technical Headquarters, Mitsubishi Heavy Industries, Ltd., Takasago, Hyogo Pref., Japan, Bull. JSME, 24 (192), pp 1029-1036 (June 1981) 10 figs, 1 table, 11 refs

Key Words: Shells, Cylindrical shells, Containers (tanks), Storage tanks, Fluid-filled containers, Seismic response

A seismic response analysis of a cylindrical liquid storage tank subjected to a horizontal seismic wave is made by the energy method in this paper. The kinetic and strain energies of an empty tank shell are calculated by the axisymmetric shell analysis computer code. The kinetic energy of the liquid in the tank is also calculated analytically by assuming that it follows the velocity potential theory neglecting the effect of the free surface oscillation.

82-136
Free Torsional Vibrations of a Hollow Cylinder with Laminated Periodic Structure

R.K. Kaul and C.S. Lee
Dept. of Engrg. Science, Aerospace Engrg. and Nuclear Engrg., State Univ. of New York at Buffalo, Rept. No. 122, 46 pp (Feb 1981)
AD-A097 163

Key Words: Shells, Cylindrical shells, Layered materials, Torsional vibration, Periodic structures

The theory of torsional vibrations of a circular, hollow cylinder with a piecewise constant periodic variation of rigidity modulus and mass density is developed in terms of Floquet waves. The dispersion spectrum is shown to have band structure, and the arrangement of characteristics sequence at the end-points of the Brillouin zone is studied. The problem of co-existence of periodic solution is examined in detail.

82-137
Optimum Design of Stiffened Conical Shells with Natural Frequency Constraints

S.S. Rao and E.S. Reddy
Dept. of Mech. Engrg., Indian Inst. of Tech., Kanpur, India, Computers Struc., 14 (1-2), pp 103-110 (1981)
1 fig, 3 tables, 11 refs

Key Words: Shells, Conical shells, Optimum design, Natural frequencies

The design optimization of axially loaded, simply supported stiffened conical shells for minimum weight is considered. The design variables are thickness of shell wall, thicknesses and depths of rings and stringers, number/spacing of rings and strings. Natural frequency, overall buckling strength

and direct stress constraints are considered in the design problems. Optimization results are obtained by placing the stiffeners inside as well as outside the conical shell. In both these cases, the independent effects of behavior constraints are also studied.

82-138
Transient Response of Submerged Shells Using Improved Acoustic Approximations

R. Vasudevan and F. DiMaggio
Weidlinger Associates, New York, NY, Computers Struc., 14 (3-4), pp 187-194 (1981) 10 figs, 11 refs

Key Words: Shells, Spherical shells, Submerged structures, Transient response, Shock waves, Doubly asymptotic approximation

The Doubly Asymptotic Approximation has been widely used to uncouple the equations of motion of an infinite acoustic medium for those of the structure it surrounds. Recently, two new schemes, the Improved Doubly Asymptotic Approximation and the Inertial-Damping Collocation Approximation have been proposed. All three give exact steady state responses at very low and very high frequencies, but the newer ones contain fitting matrices which may be chosen to give exact results for intermediate frequencies. In this paper, the transient response of a spherical shell to a plane step shock wave is computed by means of the Fast Fourier Transform, using each of the approximations, and the results are compared with the exact solution.

PIPES AND TUBES
(Also see Nos. 91, 200, 208)

82-139
The Dynamic Stability of a Tethered Tubular Structure

W.K. Ng
B.S. Thesis, Dept. of Aeronautical Engrg., Bristol Univ., UK, Rept. No. BU-246, 41 pp (June 1980) N81-21398

Key Words: Tubes, Underwater structures, Dynamic stability

The dynamic stability of longitudinal oscillations occurring in a tethered underwater tubular structure were investigated. Lagrange equations of motion were developed. Stability criteria were formulated with the aid to Routh's Method. These criteria depended mainly on the hydrodynamic characteristics of the tube, which had to be determined by experiment.

82-140
Study on Fluidelastic Vibration of Tube Bundle

H. Tanaka
A, Nippon Kikai Gakkai Ronbunshu, B Hen, 46, No. 408, pp 1398-1407 (Aug 1980)
ANL-Trans-1191

Key Words: Tube arrays, Heat exchangers, Vibration control, Fluid-induced excitation

Large numbers of fluid apparatus that employ tube bundles are used in various types of plants such as boilers and nuclear steam generators. Recently, however, the capacity of such equipment has been increased, one result of which is that, with the greater quantity and velocity of flow, the occurrence of accidents due to the vibration of the cylinder bundles that make up these apparatus has become considerable. Since the vibration damage of pipes results in serious accidents that can lead to the functional interruption of an entire plant, the prevention of cylinder bundle vibration is an extremely important matter. A variety of causes for the vibration of bodies due to aerodynamic forces are conceivable, one of which is fluidelastic vibration.

82-141
Parameter Identification of Heat Exchangers by the Method of Stochastic Approximation

H. Terasaka, H. Kanoh, and M. Masubuchi
Inst. for Atomic Energy, Tokyo Shibaura Electric Works, Tokyo, Japan, Bull. JSME, 24 (192), pp 1058-1063 (June 1981) 8 figs, 6 refs

Key Words: Heat exchangers, Parameter identification technique, Stochastic processes

The identification of parameters in a class of heat exchangers from output data is investigated. The system is assumed to be modeled by a set of partial differential equations which contain unknown parameters linearly. The method of collocation is used to transform the partial differential equations into a discrete system. The unknown parameters are identified using the stochastic approximation method. The principle of this identification technique is demonstrated by an experiment with favorable results for a parallel heat exchanger.

82-142
Match Hydraulic-Transient Analysis to Powerplant Water-System Needs
W. O'Keefe
Power, 125 (8), pp 73-75 (Aug 1981)

Key Words: Piping systems, Water hammer

Water hammer, the form of shock disturbance that can occur in piping systems of central stations, is a real threat that calls for state-of-the-art thinking. This paper presents the subject as it stands today.

82-143
Piping Response to Steam-Generated Water Hammer
R.L. Gruel, P.W. Huber, and W.M. Hurwitz
Dept. of Mech. Engrg., Massachusetts Inst. of Tech., Cambridge, MA, J. Pressure Vessel Tech., Trans. ASME, 103 (3), pp 219-225 (Aug 1981) 9 figs, 4 tables, 5 refs

Key Words: Piping systems, Water hammer

Theoretical estimates are presented for the impulse generated by the collapse of a steam bubble trapped by a column of subcooled liquid in a pipe. Predictions are compared with experimental results obtained in a laboratory scale test system. The excitation of pipe responses by the transmission of the water hammer impulse through pipe bends is discussed and predictions are presented for two simple piping configurations. Experimentally measured pipe deflections excited by a steam-generated water hammer are compared with the predictions.

DUCTS

82-144
A Theoretical Approach to Sound Propagation and Radiation for Ducts with Suppressors
E.J. Rice and D.T. Sawdy
NASA Lewis Res. Ctr., Cleveland, OH, Rept. No. NASA-TM-82612, E-863, 44 pp (1981)
N81-22837

Key Words: Ducts, Acoustic linings, Noise reduction, Acoustic absorption

The several phenomena involved in theoretical prediction of the far-field sound radiation attenuation from an acoustically lined duct were studied. These include absorption by the suppressor, termination reflections, and far-field radiation. Extensive parametric studies show that the suppressor absorption performance can be correlated with mode cut-off ratio or angle of propagation. The other phenomena can be shown to depend explicitly upon mode cut-off ratio. A complete system can thus be generated which can be used to evaluate aircraft sound suppressors and which can be related to the sound source through the cut-off ratio-acoustic power distribution.

82-145
Numerical Techniques in Linear Duct Acoustics - A Status Report
K.J. Baumeister
NASA Lewis Res. Ctr., Cleveland, OH, J. Engrg. Indus., Trans. ASME, 103 (3), pp 270-281 (Aug 1981) 9 figs, 1 table, 72 refs

Key Words: Ducts, Variable cross section, Sound propagation, Finite difference technique, Finite element technique

A review is presented covering both finite difference and finite element analysis of small amplitude (linear) sound propagation in straight and variable area ducts with flow, as might be found in a typical turbojet engine duct, muffler, or industrial ventilation system. Both steady-state and transient theories are discussed. Emphasis is placed on the advantages and limitations associated with the various numerical techniques. Examples of practical problems are given for which the numerical techniques have been applied.

BUILDING COMPONENTS
(Also see No. 95)

82-146
Steel Struts under Severe Cyclic Loadings
E.P. Popov and R.G. Black
Dept. of Civil Engrg., Univ. of California, Berkeley, CA, ASCE J. Struc. Div., 107 (9), pp 1857-1881 (Sept 1981) 18 figs, 3 tables, 16 refs

Key Words: Walls, Reinforced concrete, Concretes, Frames, Steel, Seismic design

The results of cyclic experiments on 24 struts of different steel shapes of sizes employed in practice are reported in

this paper. The geometries of some of the specimens were so selected that they also simulate some frequently used sections of larger members. The reported hysteric loops provide a wide range of data on the inelastic behavior of struts under severe reversing loads. An approach for predicting analytically the deteriorating capacity of struts under extreme load reversals is suggested. Some practical implications resulting from this work are summarized.

82-147

Transient Analysis of Structural Members Using a Continuous Space Continuous Time Method

J.S. Strenkowski, F.H. Chu, and W.D. Pilkey

Dept. of Mech. and Aerospace Engrg., North Carolina State Univ., Raleigh, NC, Computers Struc., 14 (1-2), pp 89-95 (1981) 2 figs, 26 refs

Key Words: Structural members, Rods, Beams, Plates, Transient response

A technique is developed for the transient analysis of a general class of structural members, such as rods, beams, and plates. Generality is provided by allowing the members to possess general viscous damping, non-homogeneous boundary conditions, and to be subjected to arbitrary forcing functions. The spatial solution is provided by the Riccati transfer matrix method, which is ideally suited to this class of members. The time problem is solved in the Laplace transform plane. Inversion of the transform is achieved using the Fast Fourier Transform. The computational efficiency of this technique is demonstrated by examples of a rod and a beam loaded by a suddenly applied force.

82-148

Damping of Building Structures

R.J.M. Craik

Dept. of Building, Heriot-Watt Univ., Chamber Street, Edinburgh, UK, Appl. Acoust., 14 (5), pp 347-359 (Sept-Oct 1981) 12 figs, 8 refs

Key Words: Buildings, Walls, Floors, Damping coefficients

It is shown that the damping of a wall or floor can be predicted from a knowledge of the structure and that predicted values agree well with measured values of the total loss factor. Design charts are presented which enable the total loss factor of walls and floors to be quickly calculated. A comparison with measured results shows very good agreement.

82-149

Guidelines for Mitigation of Seismic Hazards in Tilt-Up-Wall Structures, Phase I

S.A. Adham

Agbabian Associates, El Sugundo, CA, Rept. No. NSF/CEE-81002, 97 pp (Feb 1981) PB81-192817

Key Words: Buildings, Walls, Seismic design

Efforts to mitigate seismic hazards in tilt-up-wall (TUW) construction are evaluated. Analytical methods that can be used to determine the seismic response of TUW structures are described. Seismic response of a typical warehouse building with plywood roof diaphragms supported on TUW panels was studied using a lumped parameter model. Experimental data on loading and unloading of plywood diaphragms were idealized. A nonlinear stress/strain relationship was included in the model together with viscous damping. A strong motion earthquake record was used as input to the analyses which indicate that the interaction of plywood diaphragms and panels during earthquakes results in amplified forces at the panel connections to the diaphragms, and in amplified moments at the mid-height of the panel.

82-150

Seismic Behavior of Precast Curtain Walls in High-Rise Buildings

R.L. Sack, R.J. Beers, Jr., D.J. Rains, V.A. Sessa, and D.L. Thomas

Dept. of Civil Engrg., Idaho Univ., Moscow, ID, Rept. No. NSF/CEE-81003, 352 pp (Jan 1981) PB81-193039

Key Words: Walls, Multistory buildings, Buildings, Seismic response, Fatigue life

Investigations to explore the nature of curtain wall participation in the structural response characteristics of high rise buildings subjected to seismic excitation are reported. Structural plans from a number of typical buildings were studied to establish current practice. Four basic insert types, plus various combinations of types of connector bodies, were tested to obtain static stiffness properties and low cycle fatigue data. Full scale tests were run on a one-story, single bay structure. The assemblage was subjected to several earthquakes using a closed loop servocontrolled hydraulic loading system. Exceedance levels, power spectra density, and time response plots were obtained for approximately twelve transducers. These studies were augmented with a finite element representation of the assemblage to study the static and dynamic response. Experimental data were utilized in a feedback loop to the analytical model studies to allow crosschecking and improvement of the structural idealization.

DYNAMIC ENVIRONMENT

ACOUSTIC EXCITATION

(Also see Nos. 29, 249)

82-151

An Analysis of Effective Shear Modulus for Flexural and Extensional Waves and Its Application to Reflection of Sound by a Plate

P.S. Dubbelday and A.J. Rudgers

Dept. of Physics and Space Sciences, Florida Inst. of Tech., Melbourne, FL, J. Acoust. Soc. Amer., 70 (2), pp 603-614 (Aug 1981) 6 figs, 2 tables, 18 refs

Key Words: Plates, Sound reflection

An analytical expression is presented for the correction factor that relates the effective shear modulus in Timoshenko-Mindlin plate theory to the actual shear modulus, for an unloaded plate. This expression is obtained by comparison of the approximate theory with exact elasticity theory. A thick-plate theory is developed for extensional waves, which also introduces an effective shear modulus, with a corresponding correction factor. It is shown analytically that both correction factors produce the proper high-frequency value for the phase speed, namely, the Rayleigh wave speed. Reflection of sound by a plate is described when both flexural and extensional waves are excited. Both types of waves are described by the expressions derived in thick-plate theory. A structural response function of the plate for reflection is given for each of the two wave types separately. The structural response function pertaining to the case where both wave types occur simultaneously is expressed in terms of the two individual response functions in the same way that the total impedance of a pair of impedances in parallel is expressed in terms of the values of the individual impedances. The distribution of kinetic energy over the two types of waves as a function of the angle of incidence is shown.

82-152

Transition Matrix in Acoustic Scattering by a Strip

P.M. van den Berg

Dept. of Electrical Engrg., Lab. of Electromagnetic Res., Delft Univ. of Tech., Delft, The Netherlands, J. Acoust. Soc. Amer., 70 (2), pp 615-619 (Aug 1981) 1 fig, 6 refs

Key Words: Acoustic scattering, Strips, Discontinuity-containing media

The transition matrix describing the scalar scattering by a strip has been obtained using a boundary-integral-equation technique. It avoids the procedure of the extended boundary condition, taking the strip as the limit of an elliptic cylinder. Our final results confirm the known results obtained from the extended-boundary-condition technique. The method presented in this paper seems to be very attractive to similar problems in elastodynamic scattering.

82-153

Comparison of Coupled-Mode Theory with the Small-Waveheight Approximation for Sea-Surface Scattering

S.T. McDaniel

Appl. Res. Lab., Pennsylvania State Univ., University Park, PA, J. Acoust. Soc. Amer., 70 (2), pp 535-540 (Aug 1981) 4 figs, 17 refs

Key Words: Acoustic scattering, Oceans

The coupled-mode theory of sea-surface scattering is shown to be identical to the small-waveheight theory for the case of a deep isovelocity ocean where the modal spectrum forms a continuum. Numerical calculations demonstrate that the same results are also obtained for a shallow-water example where the modal spectrum is discrete.

82-154

Consistent Coupled Mode Theory of Sound Propagation for a Class of Nonseparable Problems

S.R. Rutherford and K.E. Hawker

Appl. Res. Labs., Univ. of Texas at Austin, TX, J. Acoust. Soc. Amer., 70 (2), pp 554-564 (Aug 1981) 9 figs, 13 refs

Key Words: Underwater sound, Sound propagation

This article examines the effects of boundary condition approximations that arise whenever the coupled mode theories of A.D. Pierce are applied to propagation problems involving range dependent boundaries. This boundary condition approximation requires that the depth derivative, rather than the normal derivative of the field, be continuous across a sloping interface. The approximation is necessary in order to carry out the partial separation of depth and range variables effected in the mathematical formulation of the theory. This article shows that a consequence of this approximation

is that conventional coupled mode theory applied to dissipationless media with nonhorizontal boundaries does not conserve energy. It is shown that a correction to coupled mode theory can be derived such that the proper boundary conditions are satisfied and energy is conserved to first order in the local bottom slope. Moreover, the corrections are not prohibitive in terms of added computational complexity. Numerical examples are presented which illustrate the nonconservation of energy effect and the corrections to the theory.

82-155

An Evaluation of a Simplified Near Field Noise Model for Supersonic Helical Tip Speed Propellers

J.H. Dittmar

NASA Lewis Res. Ctr., Cleveland, OH, Rept. No. NASA-TM-81727, E-768, 24 pp (Mar 1981) N81-22836

Key Words: Propeller noise, Noise prediction

Existing propeller noise models are versatile and complex but require large computational times, therefore a simplified noise model that could be used to obtain quick noise estimates for these propellers was evaluated. This simplified noise model compared favorably with a complex model for a straight blade propeller and for swept propeller blades when the propeller sweep was properly considered. The simplified model can thus be used as an approximation to the complex model. Comparisons of either the complex or simplified noise models with the available noise data are not good for supersonic propeller helical tip speeds. By adjusting various constants in the simplified model, the noise estimates can be brought into the same range as the data at the propeller design point but the variation of the model with helical tip Mach number remains different than the data.

82-156

Industrial Noise Pollution - Part 1: The Nature and Extent of the Problem

R.E. Liebich

United Engineers & Construction, Inc., a subsidiary of the Raytheon Co., Philadelphia, PA, Mech. Engrg., 103 (7), pp 34-43 (July 1981) 19 refs

Key Words: Noise reduction, Industrial facilities

Recognizing and defining the nature and extent of industrial noise pollution is the first step in coming to grips with an increasingly serious problem. Three further articles in the series will deal with various methods of reducing to an acceptable minimum the dangers of this industrial hazard.

82-157

Machinery Noise Predictions at the Design Stage Using Acoustic Modelling

R.K. Jeyapalan and N.A. Halliwell

Inst. Sound Vib. Res., Univ. of Southampton, Southampton, UK, Appl. Acoust., 14 (5), pp 361-376 (Sept - Oct 1981) 10 figs, 19 refs

Key Words: Machinery noise, Noise prediction, Sound pressure levels

This paper presents a simple method of predicting the L_{eq} sound pressure levels in the operator's position for a machine while the latter is still at the design stage. Simple acoustic models are used to estimate mean values for the transfer functions between vibrational response and sound pressure at a point. Given a force input to a structure (machine) and the subsequent vibration response, which can be calculated by finite element or other means, it provides a quick and easy method of accurately predicting overall rms sound levels. The method is applied and provided with data obtained from a full-scale industrial drop hammer. It is applicable to any machine which can be identified as a distribution of separate sound sources.

82-158

An Optical Scale Model of Traffic Noise Propagation in an Urban Environment

G. Kerber and R. Makarewicz

Inst. of Acoustics, A. Mickiewicz Univ., Poznan, Matejki, Poland, Appl. Acoust., 14 (5), pp 331-345 (Sept - Oct 1981) 10 figs, 2 tables, 17 refs

Key Words: Traffic noise, Sound propagation, Mathematical models

Principles of modeling traffic noise using an optical scale model are described. The main difference between this model and the widely used 'acoustical' scale model is that it makes use of light instead of sound. There are four phases to the study: the propagation of single vehicle noise over ground and its dependence upon distance and vehicle velocity; light emitted by a small lamp, which imitated a single vehicle; principles of the optical model, its construction and use in predicting the equivalent level, L_{eq}, of traffic noise; and a model of a part of a residential area of Poznan, Poland, was built and values of L_{eq} computed. These results were compared with field measurements.

82-159

National Exposure to Highway Noise through the Year 2000

K.J. Plotkin

Wyle Labs., Wyle Research, Arlington, VA, Rept. No. WR-77-13, 113 pp (July 1979)
PB81-175952

Key Words: Traffic noise, Noise prediction

Calculations have been made of the exposure of people to highway noise in urban areas of the United States from 1974 through 2000. Roadside noise level contours and the numbers of people exposed were calculated in ten sample cities, using a previously developed noise model, traffic parameters obtained from local authorities, and U.S. Census tract data. National totals and future exposure were projected using census bureau data and projections. Future noise exposure was calculated for several scenarios, including do nothing, existing EPA regulations, and several proposed regulations. Parametric analyses were made of operational regulations versus new vehicle standards, automobile versus truck noise, and high speed versus low speed noise. Conclusions were made as to the efficacy of various approaches and the relative importance of driveline versus tire noise and automobiles versus trucks.

82-161

Local Characterization of Free-Field Ground Motion and Effects of Wave Passage

J.E. Luco and D.A. Sotiropoulos

Dept. of Appl. Mechanics and Engrg. Sciences, Univ. of California, San Diego, La Jolla, CA, Rept. No. NSF/RA-800442, 40 pp (Feb 1980)
PB81-178089

Key Words: Seismic waves, Wave propagation, Ground motion, Foundations, Buildings

A simple model of the seismic source and propagation medium is used to obtain a local representation of the free-field ground motion in terms of a small number of equivalent dispersive plane waves. The seismic source is represented as a dislocation distributed over a small area on a vertical fault plane. The propagation medium is represented as a layered elastic half-space. Numerical values for the equivalent phase velocities entering in the representation are included for different epicentral distances and source depths. Based on the local characterization of the free-field motion, estimates of the magnitude of the effects of nonvertically incident seismic waves on the response of foundations and structures are reported.

SHOCK EXCITATION

(Also see Nos. 39, 87)

82-160

A Panel Method to Determine Loads on Oscillating Airfoils in Transonic Flow with Embedded Shock Waves

M.H.L. Hounjet

Natl. Aerospace Lab., Amsterdam, The Netherlands, Rept. No. NLR-MP-80005-U, 10 pp (Mar 1980)
N81-20039

Key Words: Airfoils, Shock waves

A two dimensional panel method which combines supersonic and subsonic linear lifting surface theories is based on the velocity potential panel approach and accounts for the effect of the moving shock. A simplified representation of a mean steady symmetric flow field which is divided into a supersonic constant Mach number region separated by a straight normal shock is used.

82-162

Some Properties of the Non-Stationary Interaction of Two Shock Waves with a Wedge

M.K. Beryozkina, M.P. Syshchikova, A.N. Semenov, and I.V. Krassovskaya

Academy of Sciences of the USSR, A.F. IOFFE Physico-Technical Inst., Leningrad, USSR, Arch. Mechanics, 32 (5), pp 621-631 (1980) 6 figs, 4 tables, 13 refs

Key Words: Shock wave propagation, Wedges

The non-stationary interaction of two shock waves following one another with a fixed wedge has been investigated. The experiments were carried out in a two-diaphragm shock tube on wedges with apex angles $\beta = 30^{\circ}, 45^{\circ}, 48{,}5^{\circ}$. The ranges of gas density ratios on the fronts of the first and the second shock waves were 2.8 - 3.6 and 1.1 - 2.3, respectively. The systems of gasdynamic discontinuities developing at the shock-shock interaction and the interaction of shocks with contact discontinuities and solid surfaces were analyzed using large-scale shadow photos of the flow over the wedge. The data obtained show pressure changes on the wedge surface during the non-stationary interaction stage.

82-163
Shock Wave Interaction with Cylindrical Surfaces
L.G. Gvozdeva, T.V. Bazhenova, Y.P. Lagutov, and V.P. Fokeev
Academy of Sciences of USSR, Inst. of High Temperatures, Moscow, USSR, Arch. Mechanics, 32 (5), pp 693-702 (1980) 6 figs, 11 refs

Key Words: Shock wave reflection, Cylinders, Shock tube testing

Experimental investigation of the reflection of plane shock waves at convex (R = 100 mm) and concave (R = 123 mm) circular cylinders has been made. The experiments were carried out in a shock tube of rectangular cross-section. The surface of the cylinder intersected the wall of the shock tube at different angles α. When the angle α was positive, the shock wave was reflected and when the angle α was negative, it was diffracted. The shadowgraphs taken at different moments of time were used to determine the triple point trajectory and angle of transition from Mach to regular reflection ω_c. The analysis of the results which were obtained with the values of the angle ω_c reported by other authors for different cylinder radii shows that the transition angle does not depend on the cylinder radius, but is fully determined by the angle of intersection.

VIBRATION EXCITATION

82-164
Dynamic Response of Tuned Secondary Systems
G.C. Ruzicka and A.R. Robinson
Dept. of Civil Engrg., Univ. of Illinois at Urbana-Champaign, Rept. No. STRUCTURAL RESEARCH SER-485, UILU-ENG-80-2020, NSF/RA-800427, 145 pp (Nov 1980)
PB81-175820

Key Words: Tuned frequencies, Dynamically tuned structures, Single degree of freedom systems, Multidegree of freedom systems, Coupled systems

This study investigates the dynamic response of secondary systems tuned to a natural frequency of the primary system. Consideration is given to simple structural models composed of a single-degree-of-freedom primary system. Formulas for the response of the secondary system are obtained for various damping configurations. The effects of a slight detuning of the secondary system are also examined. The response expressions are then used to develop estimates for the maximum response of the secondary system. The accuracy of these estimates is assessed in a numerical study in which the exact and approximate responses are compared. An expression is obtained for the response of a multi-degree-of-freedom tuned secondary system attached to a multi-degree-of-freedom primary system.

82-165
Behavior of Self-Excited Chatter Due to Multiple Regenerative Effect
Y. Kondo, O. Kawano, and H. Sato
Osaka Factory, Japan Natl. Railways, Osaka, Japan, J. Engrg. Indus., Trans. ASME, 103 (3), pp 324-329 (Aug 1981) 16 figs, 1 table, 13 refs

Key Words: Chatter, Self-excited vibrations

The behavior of self-excited chatter after an excitation is studied by introducing the new idea of a multiple regenerative effect. This considers not only the effect of one turn before, but that of two or more turns before. The analysis explains well some characteristics of the chatter, such as the finite amplitude after the onset, and the generation of chatter marks. Increase of the stability at low cutting speeds is also discussed in terms of a resistive force due to the relative motion between work and tool.

82-166
Another Look at Ackerberg-O'Malley Resonance
M. Williams
Dept. of Mathematics, Virginia Polytechnic Inst. and State Univ., Blacksburg, VA, SIAM J. Appl. Math., 41 (2), pp 288-293 (Oct 1981) 17 refs

Key Words: Resonant frequencies, Perturbation theory

Ackerberg-O'Malley resonance in the singularly perturbed turning point problem is considered. A variational approach suggested by Grasman and Matkowsky is exploited to explain previously overlooked resonance phenomena. Several examples are presented.

82-167
Resonance for Singular Perturbation Problems
H.-O. Kreiss
Dept. of Appl. Mathematics, California Inst. of

Tech., Pasadena, CA, SIAM J. Appl. Math., 41 (2), pp 331-344 (Oct 1981) 12 refs

Key Words: Resonant frequencies, Perturbation theory

Consider the resonance for a second-order equation $\epsilon y'' - xpy' + qy = 0$. Another proof is given for the necessity of the Matkowsky condition and the connection with a regular eigenvalue problem is established. Also, if p, q are analytic, necessary and sufficient conditions are derived.

82-168
Stochastically Perturbed Resonance
J.C. Neu
Dept. of Mathematics, Stanford Univ., Stanford, CA, SIAM J. Appl. Math., 41 (2), pp 365-369 (Oct 1981) 3 refs

Key Words: Oscillators, Resonant frequencies, Perturbation theory

The motion of a periodically forced oscillator whose natural frequency is the superposition of a slowly varying component and a small stochastic perturbation is analyzed. When the slowly varying component of natural frequency passes through the value corresponding to the forcing, resonance occurs. The purpose of this study is to understand the effect of the resonance on the stochastic processes of the oscillator's amplitude and phase.

82-169
Harmonic Generator
O.E. Rittenbach
Dept. of the Army, Washington, DC, 26 pp (May 6, 1981)
PAT-APPL-6-260 868

Key Words: Harmonic excitation

This application discloses a harmonic frequency generator responsive to an input signal of frequency f which changes slowly in both frequency and amplitude and characterized in that the output signal (harmonic) amplitude remains proportional to the input signal amplitude; and the output frequency nf of the output signal consists solely of one integral ($n > 1$) multiple of the input signal frequency.

82-170
The Phenomenon of Dynamic Stall
W.J. Mccroskey
NASA Ames Res. Ctr., Moffett Field, CA, Rept. No. NASA-TM-81264, A-8464, 33 pp (Mar 1981)
N81-20029

Key Words: Airfoils, Stalling, Vortex shedding

The general features of dynamic stall on oscillating airfoils are explained in terms of the vortex shedding phenomenon, and the important differences between static stall, light dynamic stall, and deep stall are described. An overview of experimentation and prediction techniques is given.

MECHANICAL PROPERTIES

DAMPING

(Also see Nos. 73, 96, 148)

82-171
Multiple Plate Hydrostatic Viscous Damper
L.P. Ludwig
NASA Lewis Res. Ctr., Cleveland, OH, PAT-APPL-6-238 887, 7 pp (Feb 27, 1981)

Key Words: Dampers, Viscous damping, Plates, Shafts (machine elements), Rotors

A device for damping radial motion of a rotating shaft is described. The damper comprises a series of spaced plates extending in a radial direction. A hydraulic piston is utilized to place a load in these plates. Each annular plate is provided with a suitable hydrostatic bearing geometry on at least one of its faces. This structure provides a high degree of dampening in a rotor case system of turbomachinery in general. The damper is particularly useful in gas turbine engines.

82-172
Some Notes to Dynamical Solution of the Mechanical System with the Microslips and Dry Friction (Poznámky k dynamickému riešeniu mechanických sústav s mikroposuvmi so suchým trením)
J. Murin

Inst. of Machine Mechanics of the Slovak Academy of Sciences, Dúbravská cesta, Bratislava, Czechoslovakia, Strojnicky Časopis, 32 (1), pp 47-63 (1981) 12 figs, 2 refs
(In Slovak)

Key Words: Coulomb friction, Frequency response

Some dynamical properties of the mechanical systems in which microshifts with Coulomb friction may occur are investigated. In dependence of the system's parameters the frequency resonance bands are calculated in which microshifts and stiffness matrix variations take place. The dynamic magnification factors on the boundary of the evaluated resonant frequency bounds are assessed.

FATIGUE

(Also see Nos. 10, 102, 105, 111, 197, 198, 199, 210)

82-173

The Role of Similitude in Fatigue and Fatigue Crack Growth Analyses

B.N. Leis and D. Broek
Battelle, Columbus Labs., Columbus, OH, Shock Vib. Dig., 13 (8), pp 15-28 (Aug 1981) 5 figs, 69 refs

Key Words: Fatigue life, Reviews

The role of similitude between damage states being compared during fatigue crack initiation and propagation analyses based on laboratory specimen tests is considered. The review focuses on developments during the last several years pertinent to ensuring similitude in damage processes, beginning with a review of the technology to the present in terms of measures of damage, crack nucleation, crack growth, and the marriage of nucleation and growth analysis. Developments pertinent to these topics based on the past several years are elaborated and reference is made to multiaxial, thermal, and environmental effects.

82-174

Use of Parametric Description of Some Characteristics in Fatigue Life Estimation of Motor Vehicle Parts (Využití parametrického vyjádření některých charakteristik v problematice únavy automobilních dílů)

M. Hanke
ÚVMV - Motor Vehicle Res. Inst., Prague, Czechoslovakia, Strojinicky Časopis, 32 (3), pp 359-366 (1981) 6 figs, 10 refs
(In Czech)

Key Words: Fatigue life, Random excitation

Problems on discontinuous representation of random loading process and material for application in computing cumulative fatigue damage based on the use of rectangular matrix of numbers of cycles are discussed. A procedure is explained to exploit the parametric relations in description of a set of S-N curves and of Haigh's diagrams with the aim to establish an algorithm for interpolation or for calculation of the values in fields of a discrete input matrix.

82-175

Subcritical Propagation of Cracks through the Wall with a Clad during Cyclic Loading (Podkritický rozvoj trhlin stěnou s austenitickým navarem při proměnlivém namáhání)

V. Linhart
Natl. Res. Inst. for Materials (SVUM), Prague, Czechoslovakia, Strojinicky Časopis, 32 (3), pp 345-358 (1981) 10 figs, 9 refs
(In Czech)

Key Words: Fatigue life, Crack propagation, Walls

The paper evaluates the conditions for fatigue cracks propagation in the austenitic weld overlay in relation to the basic CrMoV steel of the wall. Besides the threshold condition and kinetics of crack growth the complicated conditions of crack propagation through the wall with the clad are also evaluated. Estimates of the critical size of defects are discussed and the results obtained are compared with the ASME code values.

82-176

Interpretation of the Fatigue Life Curves Using General Yield Fracture Mechanics (Interpretace křivek únavové životnosti na základě obecné lomové mechaniky)

J. Polák and M. Kelsnil
Inst. of Metallurgy Czech Academy of Science, Žižkova, Czechoslovakia, Strojnicky Časopis, 32 (3), pp 293-300 (1981) 4 figs, 8 refs
(In Czech)

Key Words: Fatigue life, Fracture properties, Crack propagation

Applying the elastic-plastic fracture mechanics the fatigue crack growth law was generalized and the crack growth rate was expressed as a function of the range of the J-integral. Using this law and knowing the geometry of the propagating crack the number of cycles necessary to propagate the original crack to half a diameter of the cylindrical body was calculated. Calculated values were compared with fatigue lives obtained experimentally. The comparison makes possible evaluation of the ratio of fatigue life spent in the stadium of fatigue crack propagation.

82-177

Fatigue Tests under Random Loads (Únavové skúšky pri náhodnom namáhaní)

M. Bílý, V. Kliman, and J. Čačko

Inst. of Materials and Machine Mechanics of the Slovak Academy of Sciences, Bratislava, Czechoslovakia, Strojnícky Časopis, 32 (3), pp 315-324 (1981) 4 figs, 8 refs

(In Slovak)

Key Words: Fatigue tests, Random excitation

The authors describe the up-to-date efforts to bring the investigation of fatigue properties nearer to real service loads with a random character. The problem of a choice of simulated statistical characteristics of a stationary or non-stationary random process is discussed. Some experimental information about the influence of the probability density of ordinates and the power spectral density shape on the endurance is presented.

82-178

Calculations of Service Life for Vibration Loading on the Base of Sequence Wöhler Curves (Lebensdauerberechnungen fur Schwingbelastungen auf der Grundlage von Folgewöhlerkurven)

G. Schott

Technische Universitat Dresden, Sektion Grundlagen des Maschinenwesens, Bereich Werkstoffwissenschaft, Germany, Maschinenbautechnik, 30, pp 310-314 (1981) 7 figs, 1 table, 8 refs

(In German)

Key Words: Fatigue life

A method is presented for the calculation of the effect of a series of variable frequency vibrations, the effect of the environmental periodic excitations, and the reduction of fatigue strength caused by fatigue damage. If the material is weakened by fatigue and the σ_m = constant, then the method may be used in the investigation of multistage as well as stochastic excitation.

82-179

The Effect of Crack-Tip Plasticity on the Determination of Dynamic Stress-Intensity Factors by the Optical Method of Caustics

A.J. Rosakis and L.B. Freund

Div. of Engrg., Brown Univ., Providence, RI, J. Appl. Mechanics, Trans. ASME, 48 (2), pp 302-308 (June 1981) 10 figs, 19 refs

Key Words: Crack propagation, Dynamic stress concentration, Optical methods

The shadow spots which are obtained in using the optical method of caustics to experimentally determine dynamic stress-intensity factors are usually interpreted on the basis of a static elastic crack model. In this paper an attempt is made to include both crack-tip plasticity and inertial effects in the analysis underlying the use of the method in reflection. For dynamic crack propagation in the two-dimensional tensile mode which is accompanied by a Dugdale-Barenblatt line plastic zone, the predicted caustic curves and corresponding initial curves are studied within the framework of plane stress and small scale yielding conditions. These curves are found to have geometrical features which are quite different from those for purely elastic crack growth. Estimates are made of the range of system parameters for which plasticity and inertia effects should be included in data analysis when using the method of caustics.

82-180

Dynamic Interference Between a Crack and a Plane Boundary (Dynamic Stress Intensity Factor Induced by a Plane Harmonic SH-wave)

H. Hanzawa, M. Kishida, and M. Asano

Tomakomai Technical College, Tomakomai, Japan, Bull. JSME, 24 (192), pp 895-901 (June 1981) 8 figs, 2 tables, 14 refs

Key Words: Dynamic stress concentration, Cracked media

There are some cases where the law of proportionality cannot apply to the stress intensity factors of cracks under various geometrical, mechanical and physical conditions. As an example of such cases, the dynamic stress intensity factors are analyzed for a crack which is parallel to a plane

boundary and impinged by a plane harmonic SH-wave. Consequently, it is shown that the cracks embedded in specimens with the same material constants and similar crack configurations have different values of normalized stress intensity factors, the values of the dynamic stress intensity factors divided by a standard value.

82-181
Instrumentation of National Physical Laboratory Fatigue Testing Machine

N.J. Baldwin, D.S. Saunders, and N.M. Burman
Materials Res. Labs., Ascot Vale, Australia, Rept. No. MRL-TN-448, 13 pp (Dec 1980)
AD-A099 293

Key Words: Fatigue tests, Test equipment and instrumentation

A National Physical Laboratory fatigue testing machine used for the fatigue pre-cracking of Charpy-sized test specimens has been instrumented. It is now possible to monitor crack growth electronically thereby reducing the operator's time in attendance at the machine from hours to minutes and improving the reproducibility of fatigue precracking.

82-182
Fracture of Structural Materials under Dynamic Loading

D.A. Shockey
SRI International, Menlo Park, CA, Rept. No. AFOSR-TR-81-0402, 39 pp (Mar 25, 1981)
AD-A098 791

Key Words: Fracture properties, Dynamic response

Classical concepts of Griffith-Irwin fracture mechanics were extended to include time effects and hence to apply to crack instability under dynamic loads. Theoretical considerations of the stress intensity histories experienced by cracks subjected to short pulse loads suggested that instability requires the crack tip stress intensity to exceed the dynamic toughness for a minimum time. This postulate was checked by experiments. Impact techniques were used to produce well-defined stress pulses in specimens of an epoxy, 4340 steel, 1018 steel, and 6061-T6 aluminum containing cracks of several lengths to observe crack instability behavior. The experimental results were not well described by static fracture mechanics, but were in accord with the minimum time postulates deduced from stress intensity histories.

82-183
Fatigue Considerations for Sizing Machinery Components

G.A. Castleberry
Con Co-Tellus, Inc., Mendota, IL, ASME Paper No. 81-DE-8

Key Words: Machinery components, Fatigue life

The methods of estimating the fatigue limit, based on constant amplitude experimental data, are reviewed. The factors used in estimating the fatigue limit which are commonly found in reference books are mentioned; but it is the purpose of this paper to discuss some of the other factors not commonly known by the design engineer. A quantitative example is presented by applying the methods to a problem of estimating the fatigue limit of a machinery component. From the discussion it is hoped that the design engineer will be better able to estimate the fatigue limit of a material, and therefore will be able to size machinery components with greater confidence.

82-184
Fatigue Crack Growth Rate Data Acquisition System for Linear and Nonlinear Fracture Mechanics Applications

J.J. Ruschau
Dayton Univ. Res. Inst., Dayton, OH, Rept. No. UDR-TR-80-83, AFWAL-TR-81-4011, 34 pp (Mar 1981)
AD-A099 376

Key Words: Fatigue life, Crack propagation, Computer-aided techniques

A computer-based, automated-data-acquisition system was developed for determining fatigue crack growth rate data for both linear and nonlinear fracture mechanics testing. The system hardware employed a desktop computer equipped with a multiprogrammer which digitized the analog test signals (load and displacement) for input to the computer. For linear elastic fracture mechanics testing the crack growth rate, da/dN, is presented as a function of the stress intensity factor range, Delta K. Compliance relationships are used to monitor crack length which is then used to calculate the stress intensity range. For nonlinear fracture mechanics testing, the crack growth rate is related to the rate of potential energy change, or Delta J. Compliance techniques are also employed to monitor crack extension. The results for both analysis methods obtained with the acquisition system are in excellent agreement with results obtained using the more conventional visual and analytical methods.

82-185

Effects of Compression-Compression Fatigue on Balanced Graphite/Epoxy Laminates with Holes

J.W. Mar, M.J. Graves, and D.P. Maass

Massachusetts Inst. of Tech., Cambridge, MA, J. Aircraft, 18 (9), pp 744-747 (Sept 1981) 10 figs, 8 refs

Key Words: Fatigue life, Layered materials, Hole-containing media

Experimental investigations have been conducted to determine the effect of stacking sequence and ply orientation on the compression-compression fatigue behavior of graphite/epoxy composites. Static compression test of $[\pm 45/0]_s$ and $[0/\pm 45]_s$ laminates were carried out prior to compression-compression fatigue tests. These laminates, which were the facings of sandwich beams, were of three different configurations: unflawed; a 0.25-in. diameter hole; and a 0.25-in. diameter hole clamped by washers held together by a loose fitting bolt. Damage initiation and growth was monitored during the tests. Comparison was made of failure modes between static and fatigue tests.

82-186

A Simple Crack Closure Model for Prediction of Fatigue Crack Growth Rates under Variable Amplitude Loading

A.U. Dekoning

Natl. Aerospace Lab., Amsterdam, The Netherlands, Rept. No. NLR-MP-80006-U, 38 pp (Jan 1980) N81-21401

Key Words: Fatigue (materials), Aluminum, Crack propagation, Computer programs

A model for the prediction of growth rates of fatigue cracks in aluminum alloys is presented. It is based on an approximate description of crack closure behavior and can be used to predict effects of crack growth acceleration and retardation observed experimentally under variable amplitude loading. The model accounts for load interaction effects and for plane strain to plane stress transition. A computer program was developed for analysis of fatigue crack growth, and was used to analyze the effect for certain parameter variations in a flight simulation load spectrum on the crack growth rate.

82-187

Necessity of the Dynamic Fracture Development (Potreba rozvoje lomove dynamiky)

J. Němec

Czech Technical Univ., Faculty of Nuclear Science and Physical Engrg., Prague, Czechoslovakia, Strojnicky Časopis, 32 (3), pp 259-263 (1981) 1 fig
(In Czech)

Key Words: Fracture properties, Metals

Critical analysis of the validity of the linear fracture mechanics model in fracture process is given from the viewpoint of the description of the structural characteristics of the metallic materials as well as the viewpoint of the influence of the stress volume of the whole body or complex structure. This contribution is to show the great significance of the dynamic fracture mechanics.

82-188

Model for Predicting the Indexes of Reliability of Dynamic Load Structures (Výpoctový model pro predikci ukzatelů spolehlivosti únavově namáhaných strojních součástí)

V. Havlicek and J. Kolar

ČKD PRAHA, Res. Inst. for Diesel-locomotives, Prague, CSSR, Strojnicky Časopis, 32 (3), pp 335-344 (1981) 5 figs, 21 refs
(In Czech)

Key Words: Fatigue life, Metals

This paper deals with the design, realization and checking of a model for computing the indexes of reliability of dynamic loaded structures. The model is based on the synthesis of up-to-date states of theory of fatigue of metal materials, theory of limit states and general theory of reliability. The theoretical and methodological algorithm is transformed into computation programs.

82-189

Fatigue Strength of Low Carbon Steels under Random Loads (Únavova pevnost konstrukčních oceli při náhodném způsobu namáhání)

J. Kermes, J. Proskovec, and J. Vojtisek

Central Res. Inst., Škoda, Plzeň, Czechoslovakia, Strojnicky Časopis, 32 (3), pp 301-314 (1981) 13 figs, 8 refs
(In Czech)

Key Words: Fatigue life, Steel, Random excitation

The paper describes experimental results obtained when investigating behavior of ferritic-pearlitic and sorbitic steels

under random loads. Attention is also paid to the influence of some factors as the irregularity factor change and the change of the white noise upper limit frequency. The experimental endurance curves are compared with the theoretical ones calculated according to the best known damage hypotheses in combination with the most frequently used methods of random process analysis. A comparison of fatigue crack propagation rates under harmonic and stochastic loads is also presented.

ELASTICITY AND PLASTICITY

82-190
Linear Dynamic Thermoelasticity - A Survey

J. Ignaczak
Polish Academy of Sciences, ul. Swietokrzyska, Warsaw, Poland, Shock Vib. Dig., 13 (9), pp 3-8 (Sept 1981) 50 refs

Key Words: Reviews, Thermoelasticity

This survey presents a historical development of linear dynamic thermoelasticity over the last 30 years. A linear theory of non-steady heat conduction is combined with elastodynamics to describe thermo-mechanical processes in a solid body. Because of the complicated structure of the governing equations, only a few one-dimensional initial-boundary value problems have thus far been solved in a form that allows their complete analysis. A relatively large number of problems that have been solved successfully concern periodic thermoelastic disturbances. The reason is that the periodicity hypothesis allows the reduction of the governing equations to classical Helmholtz equations with complex-valued wave numbers and to application of the methods of classical elastodynamics to solution of actual problems. The survey also includes descriptions of fundamental results and of a basic system of field equations for dynamic thermoelasticity with relaxation times. Suggestions concerning areas of the theory that are critically in need of further investigations are given.

82-191
Transient Response of an Infinite Elastic Solid to a Moving Point Load

K. Watanabe
Dept. of Mech. Engrg. II, Tohoku Univ., Sendai, Japan, Bull. JSME, 24 (193), pp 1115-1122 (July 1981) 7 figs, 13 refs

Key Words: Elastic media, Transient response, Moving loads, Point source excitation, Shock waves

Transient response of an infinite elastic solid to a moving point load is considered. An analytical solution procedure is presented for solving a three dimensional problem of the moving load. The load motion is largely arbitrary. The subject problem is reduced to a simple consideration on "arrival time function," defined in this paper. Three typical cases are discussed in detail. It is shown that analyses of waves and responses are carried out simultaneously by considering the behavior of the arrival time function and that extremum of the arrival time function gives characteristic wave fronts such as shock waves (leading waves).

EXPERIMENTATION

MEASUREMENT AND ANALYSIS
(Also see No. 212)

82-192
Pulse Width Spectrum Analyzer

F. Hayes, III and J.R. McGinty
Dept. of the Army, Washington, DC, PAT-APPL-6-205 359, 24 pp (Nov 10, 1980)

Key Words: Spectrum analyzers, Vibration measurement, Measuring instruments

Each incoming pulse has its width determined and is stored in a designated storage counter in accordance with its pulse width. The contents of the storage counters are serially addressed and the value of each counter is obtained. The value of each counter is used as a Y input to a readout and the serially addressing of the counter is used as the X input of the readout device. The count on counters are maintained within their capacity by sensing when a counter reaches its maximum value and causing all counters to down count in accordance with the input rate to this particular storage counter.

82-193
Integrating Angular Accelerometer

L.B. Taplin
Dept. of the Army, Washington, DC, PAT-APPL-6-216 416, 12 pp (Dec 15, 1980)

Key Words: Accelerometers, Vibration measurement, Measuring instruments, Measurement techniques, Shock response

The present invention is directed to an integrating angular accelerometer which has a neutrally bouyant mass, thereby eliminating the detrimental effect of high shock and vibration loads. The accelerometer includes a housing and an inertial mass positioned in the housing, arranged for relative rotation with respect to the housing. An annular channel is provided between the housing and the inertial mass, located about the acceleration sensitive axis and dimensioned to cause fluid flow upon relative rotation of the housing and inertial mass in the direction of relative rotation. The fluid contained within the channel is a viscous fluid having a density equal to that of the inertial mass so as to achieve a neutral buoyancy of the inertial mass.

82-194

Time-Domain Pulse Analysis as a Substitute for Ultrasonic Spectroscopy

O.R. Gericke

Army Materials and Mechanics Res. Ctr., Watertown, MA, Rept. No. AMMRC-TR-81-6, 21 pp (Jan 1981) AD-A098 385

Key Words: Pulse analyzers, Time domain method, Fast Fourier transform, Computer-aided techniques

A computer method, based on fast Fourier transformation principles, has been used to study various types of pulsed signals and their associated spectral functions. Theoretical criteria were developed for generating a pulse that exhibits a broad, uniform spectrum while satisfying the practical requirements of the electronic instrumentation currently available for ultrasonic testing purposes. Further investigation was made of how the time-domain appearance of such a broad-spectrum pulse is changed if the signal is subjected to various forms of frequency-dependent attenuation. The results obtained demonstrate the feasibility of establishing a systematic correlation between pulse shape and attenuation function. This leads to the conclusion that ultrasonic attenuation phenomena can be examined by means of a time-domain signal analysis in lieu of the more involved spectrum analysis.

82-195

A Probe for In-Situ Measurement of Dynamic Pore Pressure

R. Sidey

Dames and Moore, London, UK, Rept. No. AFWL-TR-81-4, AD-E200 711, 80 pp (Apr 1981) AD-A099 110

Key Words: Measuring instruments, Piezoelectric gages, Soils, Blast loads

This report details work undertaken in the development of a new design of fast response piezometer. Intended for measurement of transient pore water pressures in soils, the device features a novel two-stage emplacement technique. The system is capable of achieving a responsive coupling with the interstitial fluid in the region of measurement, and can operate over a broad range of pressures encompassing those encountered in blast loading conditions.

82-196

Phase Calibration of Hydrophones

L.D. Luker and A.L. Van Buren

Underwater Sound Reference Detachment, Naval Res. Lab., Orlando, FL, J. Acoust. Soc. Amer., 70 (2), pp 516-519 (Aug 1981) 6 figs, 6 refs

Key Words: Hydrophones, Calibrating, Measuring instruments, Sound measurement

In order to determine the waveform of an acoustic signal by analyzing the electrical output of the receiving hydrophone, the phase angle as well as the amplitude of the receiving hydrophone sensitivity must be known as a function of frequency. Unless the frequency is well below the lowest hydrophone resonance, this phase angle varies considerably with frequency. This paper describes the extension of conventional amplitude reciprocity calibration to include phase. It also describes a unique measurement configuration that eliminates phase errors resulting from uncertainties in measurement distances and sound speed. Several hydrophones are calibrated using the new procedure. Measured phase-angle results are in good agreement with theoretical results based on diffraction-constant calculations.

82-197

Acoustic Emission Signature Analysis. Technical Progress Report No. 2, 1 March 1979 - 29 February 1980

O. Buck and W.J. Pardee

Science Ctr., Rockwell International, Thousand Oaks, CA, Rept. No. 2, 36 pp (Mar 1980) DOE/ER/02029-T1

Key Words: Acoustic emission, Signature analysis, Glass, Steel, Fatigue life

Acoustic emission in plate glass and steel has been studied as a function of angle. The low frequency AE in glass (< 1 MHz) was studied in detail, and contributions from P, S and Rayleigh waves identified. These results are isotropic, as expected theoretically. Limited high frequency (5-20 MHz) results have been obtained in glass. This is the first time that AE energy has been measured above 3 MHz. The measurement of AE on transgranular crack growth in steel during fatigue crack growth was accomplished by use of a low noise manual hydraulic loading system and an electronic gate to reject grip noise. The concept of the wave momentum of an AE was elaborated and a measurement technique suggested. The theoretical study of this problem led to the discovery of an infinite, previously unknown, family of elastic surface (Rayleigh-like) waves, and to further cylindrical, radially propagating plate waves. It appears these waves may be useful in other areas of ultrasonics.

82-198

Dynamic Photoelasticity as an Aid to Sizing Surface Crack by Frequency Analysis

A. Singh, C.P. Burger, L.W. Schmerr, and L.W. Zachary

Ames Lab., IA, Rept. No. CONF-8009135-1, 20 pp (Apr 1980) (Paper pres. at Conference on mechanics of nondestructive testing, Blacksburg, VA, USA, Sept 10, 1980)
IS-M-288

Key Words: Measurement techniques, Photoelastic analysis, Cracked media, Discontinuity-containing media

A method using Rayleigh or surface waves for sizing surface cracks that have been modeled as machine slots is described. Dynamic photoelasticity was chosen to study the overall wave behavior and the mode conversions of a Rayleigh wave as it interacts with narrow slots cut from the edges of a two-dimensional plate model. This technique gives a full-field visualization of the stresses produced by an elastic wave traveling in a solid. The interaction between a Rayleigh wave and a slot was observed from a sequence of pictures taken with a high-speed Cranz-Schardin camera. The procedures and results are discussed.

82-199

Crack Depth Determination by Ultrasonic Frequency Analysis Aided by Dynamic Photoelasticity

A. Singh

Ames Lab., IA, 117 pp (Aug 1980)
IS-T-900

Key Words: Photoelastic analysis, Nondestructive tests, Testing techniques, Crack detection

A non-destructive method for characterizing the depth of artificial surface-breaking flaws (slots) using Rayleigh surface waves is described. Dynamic photoelasticity was used to obtain a full-field visualization of the waves generated on interaction of a Rayleigh wave with a slot. This visualization showed that for slot lengths of the same order of size as the predominant wavelengths in the incident Rayleigh wave, there is a significant interaction of the subsurface Rayleigh disturbance with the slot tip, producing transmitted surface disturbances that were quantitatively analyzed. Specifically, the frequency content of these transmitted waves was found for four different slot depths. The high frequency components of these transmitted signals exhibited a maximum frequency which decreased with increasing slot depth. This was attributed to the fact that the maximum frequencies of the subsurface field of the incident Rayleigh wave decrease with increasing depth. Ultrasonic testing was also done on surface slots in steel blocks, using commercial Rayleigh wave transducers.

DYNAMIC TESTS

82-200

Application of Acoustic Emission Techniques to Thermal Ratcheting Tests of LMFBR Primary Coolant Piping

M. Hori, A. Imazu, H. Atsumo, A. Yoshitoshi, and T. Hattori

Power Reactor and Nuclear Fuel Development Corp., Tokyo, Japan, 42 pp (Mar 1979)
PNC-N-941-79-31
(In Japanese)

Key Words: Testing techniques, Acoustic emission, Nuclear reactors, Nuclear reactor components, Cooling systems, Piping systems

For the practical application of acoustic emission (AE) to the structural integrity monitor for the primary coolant piping of the liquid-metal fast breeder reactor, it is necessary to investigate AE characteristics of the piping components under complicated loading of mechanical and thermal stress in the presence of the background flow noise. This paper presents the cooperative work by the Power Reactor and Nuclear Fuel Development Corporation and Central Research Institute of Electric Power Industry on the AE application to thermal ratcheting tests of 304 stainless-steel pipes in the liquid-sodium Loop. The main objectives of this work

are as follows: signal acquisition under the liquid-sodium flow condition similar to the practical plant; AE characteristics during the thermal ratcheting test; and changes of AE characteristics due to various types of piping failure; degrees of structural failure.

82-201

The Daimler-Benz Roller-Type Noise Test Stand for Commercial Vehicles (Der Geräuschrollprüfstand für Nutzfahrzeuge der Daimler-Benz AG)

P. Fietz and T. Koch
Im Asemwald, Stuttgart, Germany, Automobiltech. Z., 83 (7/8), pp 335-339 (July/Aug 1981) 15 figs, 1 table
(In German)

Key Words: Test stands, Test facilities, Acoustic tests, Ground vehicles

In the commercial vehicle development area of Daimler-Benz AG in Stuttgart-Untertürkheim, a roller-type noise test stand was taken into service after approximately 1½ years of building. This report describes the construction of the system with the reflection-free room, the measuring and evaluation room, the vehicle preparation room and various storage and machine rooms. The constructional features and acoustic characteristics of the anechoic test room with its equipment and auxiliary facilities and the concept, design and operational modes of the roller-type test stand are described.

DIAGNOSTICS

82-202

Improved Low Frequency Eddy Current Inspection for Cracks under Installed Fasteners

D.T. Mih
Aircraft Div., Northrop Corp., Hawthorne, CA, Rept. No. NOR-80-142, AFWAL-TR-80-4150, 90 pp (Oct 1980)
AD-A098 543

Key Words: Diagnostic techniques, Fasteners, Crack detection

The purpose of this program was to establish the feasibility of using low frequency eddy current techniques to inspect the second layer of a built up aluminum structure for hole cracking, with the titanium fasteners installed. This program pursued two parallel approaches for low frequency eddy current inspection. One approach was with centered field excitation in the fastener hole. The second approach was with off-center field excitation in the fastener hole. The program consisted of two tasks. The first task was to optimize the probes for both approaches, and involved analysis, design, optimization of probes, and testing of various unique driver/sensor combinations. The second task was to develop inspection techniques with the optimized probes on notched specimens containing flush-head titanium fasteners with appropriate signal processing and display.

82-203

The Use of Mathematical Modeling in the Analysis of Gas Turbine Compressor Unit Test Data

L.J. Williams
Transcanada Pipelines Ltd., Toronto, Ontario, Canada, ASME Paper No. 81-GT-217

Key Words: Gas turbines, Compressors, Mathematical models, Diagnostic techniques

A very simple mathematical modeling procedure is described which allows the analyst to test his own hypothesis of engine faults and so identify instrumentation errors and discover conditions not previously considered. Application of modeling to actual test data is demonstrated.

82-204

Amplitude and Spectral Discriminants of Vibroacoustical Processes for Diagnostic Purposes

C. Cempel
Tech. Univ. of Poznan, Poznan, Poland, Strojnicky Časopis, 32 (2), pp 171-179 (1981) 4 figs, 2 tables, 6 refs

Key Words: Diagnostic techniques, Bearings, Ball bearings, Amplitude analysis, Spectrum analysis

This paper is devoted to the analysis of the known and newly defined amplitude discriminants of vibroacoustical processes. The results included in this paper are presented in a brief and different manner, and similar frequency or spectral process discriminants are defined and analyzed. Some applications in ball-bearing diagnostics are shown.

BALANCING

82-205

Apparatus for and Method of Compensating Dynamic Unbalance

J.A. Hrastar, Sr.

NASA, Goddard Space Flight Ctr., Greenbelt, MD, PAT-APPL-6-238 888, 29 pp (Feb 27, 1981)

Key Words: Balancing techniques

An apparatus to stabilize a fine platform that carries a parabolic reflecting dish, utilized in connection with the large aperture, multichannel microwave radiometer, is discussed. It provides compensation for dynamic unbalance imparted to a fixed body by a shaft about which the rotating body rotates. Force components exerted on the fixed body by the rotating body in a plane at right angles to the axis are determined. In response to the determined force components, the rotational speed and effective direction of mass means mounted on the rotating body are controlled. The mass means has an effective axis of rotation in a plane at right angles to the longitudinal axis.

82-206

Balancing for a Flexible Rotor Considering the Vibration Mode

K. Shiohata and F. Fujisawa

Mech. Engrg. Res. Lab., Hitachi, Ltd., Bull. JSME, 24 (193), pp 1223-1232 (July 1981) 9 figs, 14 refs

Key Words: Balancing techniques, Least squares method, Modal balancing technique, Rotors, Flexible rotors

A modal-least squares balancing method is derived for a flexible rotor which has both features of the modal balancing and least squares balancing methods. The effect of each correction mass, which is obtained by the above method, on the vibration is physically clarified. Even if the influence coefficients contain errors initially, they are easily corrected by applying the above method and a good balancing result is then obtained. It is described by numerical simulations how the above method is effective for the balancing of a flexible rotor.

MONITORING

82-207

Vibration Monitoring of the Mechanical Behavior of the Internal Structures of PWR Reactors

R. Assedo, J.C. Carre, and J.C. Sol

CEA Centre d'Etudes Nucleaires de Saclay, Gifsur-Yvette, France, Dept. des Etudes Mecaniques et Thermiques, Rept. No. CONF-7910173-2, 23 pp (1979) (Pres. at CEA-EDB conference cycle on vibrations of mechanical structures in industrial field, Jouy-on-Josas, France, Oct 15, 1979)

CEA-CONF-4927

(In French)

Key Words: Monitoring techniques, Nuclear reactors, Nuclear reactor components, Fluid-induced excitation

The internal structures of pressurized water reactors are the seat of vibrations induced by fluctuations in primary fluid flow. A knowledge of these phenomena is indispensable in order to ensure that the structures are in proper mechanical order. It can also be used for operational monitoring. This paper describes all the methods developed and the results already achieved in this domain. The first part deals with tests on mockup associated with the calculation models which afforded a good knowledge of the vibrational characteristics of the internal structures, as well as the measurements made during hot tests of certain reactors which made it possible to qualify these models on real structures. The second part describes the means of detection (neutron noise, external accelerometers) as well as the processing methods used in the follow-up. A few typical results obtained on site are presented.

82-208

An Acoustical Monitoring System for Early Diagnosis of Tube-Bundle Breakdown (Un Sistema Strumentale Acustico Per Diagnosi Precoci di Rotture di Fasci Tubieri)

A. Azzoni, S. Bevilacqua, A. Clapis, and G. Maino

Centro Informazioni Studi Esperienze, Milan, Italy, Rept. No. CISE-1612, 27 pp (1980) (Pres. at Pnd '80 Conf. Strumentazio, Milan, June 13-14, 1980)

(In Italian)

Key Words: Diagnostic instrumentation, Monitoring techniques, Acoustic techniques, Tube arrays, Heat exchangers

Some of the main components of an acoustical monitoring system are described. The components described are: a piezoelectric pressure transducer; an amplifier and bandpass filter for each monitoring point; a rms voltmeter; a registering device; and an alarm system. The monitoring system was based on the increase in noise level produced by the turbulent flow of fluid leaking through a crack. The technique was tested experimentally and was adopted for boilers and high pressure heat exchangers in thermoelectric plants.

82-209

Experimental Study of Advanced Continuous Acoustic Emission Monitoring of BWR Components. Final Report

J.W. McElroy and W.F. Hartman

Philadelphia Electric Co., PA, *Rept. No.* COO-4592-2, 44 pp (Sept 1980)

DOE/ET/34216-TI

Key Words: Monitoring techniques, Acoustic emission, Nuclear reactor components

The program consisted of installing, maintaining, and monitoring AE sensors located on primary piping, nozzles, and valves in the BWR system. Analysis of the AE data was correlated to the results of supplementary nondestructive testing techniques used during the in-service inspection, performed at refueling outages. Purpose of the program was to develop the on-line surveillance acoustic emission technique in order to identify areas of possible structural degradation. Result of reducing inspection time was to reduce accumulated radiation exposure to inspecting personnel and to reduce the amount of critical plant outage time by identifying the critical inspection areas during operation. The program demonstrated the capability of acoustic emission instrumentation to endure the nuclear reactor environment.

82-210

A Review of Advanced Acoustic Emission Sensors

D.K. Lemon

Battelle Pacific Northwest Labs., Richland, VA, Rept. No. 23111-04210, *NADC-81087-60*, 134 pp (Apr 1981)

AD-A098 989

Key Words: Monitoring techniques, Acoustic emission, Crack propagation, Fatigue life

This report describes work done to evaluate emerging, advanced sensors for detection of acoustic emission from fatigue crack growth. This task is part of an overall project whose objective is to develop acoustic emission monitoring of fatigue crack growth in aircraft. The operation of each candidate sensor is summarized. The criteria used to evaluate the suitability of each sensor for near-term use on this acoustic emission project is described. Recommendations are provided regarding which sensor concepts appear to be most promising within the context of the project's needs. The appendices contain papers submitted by various experts discussing the sensor concepts.

82-211

Acoustic Emission Monitoring of Polymer Composite Materials

R. Bardenheier

NASA, Washington, DC, Rept. No. NASA-TM-76523, 29 pp (Feb 1981) (Engl. transl. of Z fuer Werkstofftech., (Germany, F.R.), Vol. 11, Mar 1980, pp 101-110)

N81-20187

Key Words: Monitoring techniques, Acoustic emission, Polymers, Composite materials

The techniques of acoustic emission monitoring of polymer composite materials is described. It is a highly sensitive, quasi-nondestructive testing method that indicates the origin and behavior of flaws in such materials when submitted to different load exposures. With the use of sophisticated signal analysis methods it is possible to distinguish between different types of failure mechanisms, such as fiber fracture delamination or fiber pull-out. Imperfections can be detected while monitoring complex composite structures by acoustic emission measurements.

82-212

A Local Authority Aircraft Noise Monitoring System

G. Vulkan and J. Hyde

Greater London Council Scientific Branch, County Hall, London SE1 7PB, UK, Noise Control Engrg., 16 (3), pp 114-122 (May-June 1981) 7 figs, 5 tables

Key Words: Sound level meters, Aircraft noise

The Greater London Council, and eight of the London boroughs most affected by aircraft noise, operate an independent aircraft noise monitoring system in order to provide information for planning decisions and policy formulation. It is based on two fixed sites, mainly for monitoring landing noise, and four transportable sets of equipment which will cover about 30 locations in West London in about three years. The equipment is based on outdoor microphones linked to data loggers via threshold detectors. Cassettes are presently changed on site but it is anticipated that the two fixed sites will be converted to telemetry within a year. The present system and anticipated future developments of the aircraft noise system are explained.

ANALYSIS AND DESIGN

ANALYTICAL METHODS

82-213
Equivalent Piecewise Linearization Method for an Essentially Nonlinear Sytem

K. Tenma and S. Maezawa
Kisarazu Technical College, Kiyomidai-higashi, Kisauazu, Japan, Bull. JSME, 24 (192), pp 1021-1028 (June 1981) 7 figs, 3 tables, 6 refs

Key Words: Approximation methods, Equivalent linearization method

An approximate method of equivalent piecewise linearization for obtaining solutions of vibrations in essentially nonlinear systems is proposed. The restoring force characteristic of the system is replaced by an appropriate piecewise-linear one and a solution is obtained for this approximate system. Furthermore, a perturbation method starts from the above obtained solution as a generating solution. The adequacy of the method proposed is demonstrated by comparing approximate solutions by means of this method with exact solutions for elliptic Duffing equations of hard and soft types subjected to elliptic excitation.

82-214
Solution of Quasi-Harmonic Equations through the Combined Finite Element-Transfer Matrix Method

G. Chiatti and A. Sestieri
Instituto di Macchine e Tecnologie Meccaniche, Universita di Roma, Rome, Italy, Intl. J. Numer. Anal. Engrg., 17 (8), pp 1161-1175 (Aug 1981) 8 figs, 11 refs

Key Words: Quasi-harmonic vibration, Finite element technique, Transfer matrix method

The extension of a combined finite element-transfer matrix method to problems governed by quasi-harmonic equations is presented. Particular emphasis is given to heat conduction, and numerical results are presented for this type of problem (steady and transient cases). The principal advantage of the method with respect to finite elements concerns the minor dimension of the last matrix formulation which quite often implies a reduced computational burden. The accuracy of the method is considered by comparing the numerical results with some available analytical solutions for slabs: an excellent agreement is effectively obtained.

82-215
Analysis of Non-Axisymmetric Vibrations and the Use of Basic Element Matrices

P. Pedersen and J. Cederkvist
Dept. of Solid Mechanics, The Technical Univ. of Denmark, Lyngby, Denmark, Computers Struc., 14 (3-4), pp 255-260 (1981) 2 figs, 1 table, 6 refs

Key Words: Vibration response, Axisymmetric bodies, Matrix methods, Stiffness methods, Mass matrices, Finite element technique

Non-axisymmetric vibrations of axisymmetric solids are analyzed by the finite element method and excellent agreement with experiments is obtained. The paper focuses on the basic element matrices, which, independent of the number of nodal diameters n, give the stiffness- and mass matrix. These matrices give explicitly the dependence on n and on Poisson's ratio. Interesting asymptotic results on decouplings, eigenfrequencies and eigenmodes are obtained.

MODELING TECHNIQUES
(Also see No. 203)

82-216
Determining Load Characteristics for Transient Performance. Volume 1. Executive Summary. Final Report

T. Gentile, S. Ihara, A. Murdoch, and N. Simons
Electric Utility Systems Engrg. Dept., General Electric Co., Schenectady, NY, 42 pp (Mar 1981) EPRI-EL-850 (V.1)

Key Words: Mathematical models, Transient response

This study evaluated a prototype load modeling procedure. Tests were run on three different power systems to evaluate the procedure's accuracy in modeling the dynamic power response of loads (active and reactive) when subjected to limited excursions of voltage and frequency. In support activities, guidelines were developed for the load modeling procedure, and possible data sources for it were investigated. The period of performance was September 1976 to

July 1980. The work accomplished is reported in a final report of four volumes. In this volume test results on three power systems are reported and analyzed. An evaluation of the load modeling procedure is made.

82-217

Determining Load Characteristics for Transient Performance. Volume 2. Load-Model Guidelines. Final Report

T. Gentile, S. Ihara, A. Murdoch, and N. Simons
Electric Utility Systems Engrg. Dept., General Electric Co., Schenectady, NY, 60 pp (Mar 1981)
EPRI-EL-850 (V.2)

Key Words: Mathematical models, Transient response

This study evaluated a prototype load modeling procedure. Tests were run on three different power systems to evaluate the procedure's accuracy in modeling the dynamic power response of loads (active and reactive) when subjected to limited excursions of voltage and frequency. In support activities, guidelines were developed for the load modeling procedure, and possible data sources for it were investigated. The period of performance was September 1976 to July 1980. The work accomplished is reported in a final report of four volumes. In this volume guidelines are developed for a load modeling procedure, and induction motor characteristics and their effect on system stability are examined.

82-218

Determining Load Characteristics for Transient Performance. Volume 4. Test Results and Analysis. Final Report

T. Gentile, S. Ihara, A. Murdoch, and N. Simons
Electric Utility Systems Engrg. Dept., General Electric Co., Schenectady, NY, 86 pp (Mar 1981)
EPRI-EL-850 (V.4)

Key Words: Mathematical models, Transient response

This study evaluated a prototype load modeling procedure. Tests were run on three different power systems to evaluate the procedure's accuracy in modeling the dynamic power response of loads (active and reactive) when subjected to limited excursions of voltage and frequency. In support activities, guidelines were developed for the load modeling procedure, and possible data sources for it were investigated. The period of performance was September 1976 to July 1980. The work accomplished is reported in a final report of four volumes. This volume, the executive summary, presents an overview and summary of results. Recommendations are made for the research necessary to develop a production grade load modeling procedure.

82-219

Optimal Regulation of Structural Systems with Uncertain Parameters

D.C. Hyland
Lincoln Lab., Massachusetts Inst. of Tech., Lexington, MA, Rept. TR-551, ESD-TR-80-246, 149 pp (Feb 2, 1981)
AD-A099 111

Key Words: Mathematical models, Stochastic processes, Optimum control theory, Mean square response

Difficulties arising from inherent inaccuracies in structural modeling and from the high dimensionality of the dynamical system force a re-examination of the problem of optimal control of large flexible structures within the context of stochastic system theory. This work specifically addresses the mean-square optimal control of a linear mechanical system with random open-loop modal frequencies. Recognizing that a complete probabilistic description of modal parameters can never be provided, the minimum set of a-priori data needed to preserve any measure of modeling fidelity is identified. Acknowledging this data as available, a complete probability assignment is then induced by a maximum entropy principle. The resulting mean-square optimization problem is consequently reduced to the solution of a modified Riccati equation. Various properties of this equation are explored.

82-220

Efficient Reanalysis for Structural Dynamic Response

W.V. Nack
Aerospace Engrg. Dept., Embry Riddle Aeronautical Univ., Daytona Beach, FL, Computers Struct., 14 (1-2), pp 153-155 (1981) 2 tables, 12 refs

Key Words: Dynamic structural analysis, Finite element technique

A technique is presented which will reanalyze the dynamics of a structure due to a limited set of element changes. The method uses a reduced basis of normal modes and efficiently computes the steady state harmonic, stationary random or transient response of a large scale finite element model. The algorithms can be implemented into any general purpose

finite element code to save the vibrational analyst both time and money in the design process.

82-221

Finite Element Analysis of Harmonic Waves in Layered and Fibre-Reinforced Composites

S. Minagawa, S. Nemat-Nasser, and M. Yamada

Denkitsushin Univ., Chofu, Tokyo, Japan, Intl. J. Numer. Anal. Methods Engrg., 17 (9), pp 1335-1353 (Sept 1981) 5 figs, 7 tables, 12 refs

Key Words: Composite structures, Layered materials, Fiber composites, Harmonic waves, Finite element technique

The problem of harmonic waves in layered and fibre-reinforced composites is solved by a method of finite elements. Piecewise linear approximating functions are used for the displacement and stress fields in a mixed variational formulation, recently proposed in the form of a new quotient. Numerical computations are made for approximate phase-velocities of harmonic waves in layered composites, where asymmetric and symmetric triangular meshes, and square meshes with interior nodes, are used. To illustrate the accuracy and effectiveness of the method, these approximate solutions are compared with those given by means of exponential test functions, and the exact ones by Rytov, etc. Calculations are also performed for harmonic waves in fibre-reinforced composites. Dispersion curves for these waves are obtained and displayed graphically.

82-222

Optimization Procedure for Pulse-Simulated Response

S.F. Masri and F.B. Safford

Civil Engrg. Dept., Univ. of Southern California, Los Angeles, CA, ASCE J. Struc. Div., 107 (9), pp 1743-1761 (Sept 1981) 19 figs, 4 tables, 22 refs

Key Words: Simulation, Earthquake simulation, Buildings, Multistory buildings

A computationally efficient technique is presented for optimizing the selection of pulse train characteristics, to be used for simulating the response of general types of structural systems to arbitrary dynamic environments. The optimization procedure uses an adaptive random search algorithm that incorporates a periodic exploratory search for the optimal step-size variance, which significantly improves the convergence characteristics.

82-223

A Comparison of Localized Finite Element Formulations for Two-Dimensional Wave Diffraction and Radiation Problems

R.E. Taylor and J. Zietsman

Dept. of Mech. Engrg., Univ. College, London, UK, Intl. J. Numer. Anal. Methods Engrg., 17 (9), pp 1335-1384 (Sept 1981) 16 figs, 6 tables, 20 refs

Key Words: Numerical analysis, Boundary value problems, Off shore structures, Wave diffraction, Wave propagation, Water waves, Finite element technique

Two of the most promising localized finite element methods are compared: the boundary series element method, in which a series of eigenfunctions is used to represent the far field solution; and the boundary integral element method, in which an integral equation is satisfied at the boundary between localized finite element and outer regions. The methods are applied to water of arbitrary depth. The theory of the two methods is summarized, and typical numerical results are discussed. Consideration is given to the well-known hydrodynamical reciprocal relations, and to the phenomenon of irregular frequencies. The relative merits of the two methods are established.

NUMERICAL METHODS

82-224

Dynamic Response by Means of Functions of Matrices

L.Y. Bahar and G.E. Law

Dept. of Mech. Engrg. and Mechanics, Drexel Univ., Philadelphia, PA, Computers Struc., 14 (3-4), pp 173-178 (1981) 4 figs, 4 tables, 9 refs

Key Words: Integration, Numerical analysis, Equations of motion, Matrix functions

A method to predict the dynamic response of a linear non-conservative system with nonsymmetric parameter matrices, due to a discretized forcing function is developed. The method is based on sampled-data techniques widely used in modern control theory. However, instead of appealing to the state space approach which recasts the equations of motion into a first order system, the numerical integration is attempted directly on the second order differential equations as given. A sample problem considered in a previous matrix exponential method is worked out by the method developed here. The results indicate that the approach is well-suited for problems where the input data is known in digitized form.

82-225

Progressive Simultaneous Inverse Iteration for Symmetric Linearized Eigenvalue Problems

A. Jennings and T.J.A. Agar
Civil Engrg. Dept., The Queen's University, Belfast, UK, Computers Struc., 14 (1-2), pp 51-61 (1981)
4 figs, 7 tables, 27 refs

Key Words: Eigenvalue problems, Vibration frequencies

Simultaneous iteration and the Sturm sequence method can be used for determining partial eigensolutions of linearized eigenvalue equations arising from the analysis of undamped structural vibration problems. Both methods may be implemented with band storage of the relevant matrices and therefore are efficient when the matrices are sparse and of large order. A progressive simultaneous inverse iteration method is developed which contains some features of these two methods and has been formulated with the object of improving the numerical efficiency and reducing the storage requirements still further. Some numerical results are given.

82-226

A Fast Numerical Procedure to Solve the Meridional Equations of Motion in a Multistage Axial Flow Turbomachine

A. Kundig
Sulzer Brothers Ltd., Winterthur, Switzerland, ASME Paper No. 81-GT-133

Key Words: Numerical analysis, Equations of motion, Turbomachinery

A new numerical procedure has been developed to solve the meridional equations of motion in an axial flow turbomachine. It is based on the so-called streamline-curvature method. The primary aim of this project was to reduce the computing-time of existing programs.

82-227

Computation of the Second-Order Steady Forces Acting on a Surface Ship in an Oblique Wave

Y.-H. Kim
Ship Performance Dept., David W. Taylor Naval Ship Res. and Dev. Ctr., Bethesda, MD, Rept. No. DTNSRDC/SPD-0964-01, 58 pp (Mar 1981)
AD-A097 898

Key Words: Numerical analysis, Ships, Computer programs

The numerical procedure of calculating the second-order steady forces is presented. Ship motion and diffraction potentials are required as input data for Kochin-function calculation. In order to avoid the irregular frequencies which are associated with Frank's close-fit method, a modification which extends the source distribution onto the calm waterline inside of a body is made. For the diffraction problem, instead of a Helmholtz equation, a two dimensional Laplace's equation is used. Numerical computation for the head-sea case shows the same trend of experimental data throughout the frequency ranges but its magnitude is much larger than that of the experiment.

STATISTICAL METHODS

(Also see Nos. 219, 230)

82-228

Simulation of Stationary and Nonstationary Random Processes with a Compound Probability Density Function (Simulácia stacionárnych a nestacionárnych náhodných procesov so zloženou hustotou pravdepodobnosti)

J. Čačko and M. Bílý
Inst. of Materials and Machine Mechanics of the Slovak Academy of Sciences, Bratislava, Czechoslovakia, Strojnicky Časopis, 32 (2), pp 155-169 (1981)
2 figs, 4 refs
(In Slovak)

Key Words: Simulation, Random vibration, Probability density function, Statistical analysis

The presented paper describes a method of simulation of stationary and nonstationary random processes with compound probability density functions. It is based on the fact that many compound distributions with deterministic parameters can be expressed in the form of simple distribution with random parameters.

82-229

Non-Stationary Random Processes - Present State and Perspective of Their Classification, Analysis and Simulation (Nestacionární náhodné procesy - současný stav a perspektivy jejich klasifikace, zpracování a simulace)

M. Bílý and J. Čačko

Inst. of Materials and Machine Mechanics of the Slovak Academy of Sciences, Bratislava, Czechoslovakia, Strojnicky Časopis, 32 (2), pp 139-153 (1981) 3 figs, 9 refs
(In Czech)

Key Words: Random vibration, Spectral energy distribution techniques, Statistical analysis

The paper presents the classification of non-stationary random processes, based either on the properties of one- and two-dimensional distribution functions obtained at a set of realizations, or on the evolutionary properties of statistical characteristics of one process realization. Further it shows methods of the corresponding statistical characteristics evaluation and also the simulating algorithms for modeling of non-stationary random processes with required properties.

PARAMETER IDENTIFICATION

82-230
Parametric Vibration. Part VI: Stochastic Problems (2)
R.A. Ibrahim
Dept. of Mech. Engrg., Texas Tech Univ., Lubbock, TX, Shock Vib. Dig., 13 (9), pp 23-35 (Sept 1981) 4 figs, 28 refs

Key Words: Parametric vibration, Stochastic processes, Reviews

Recent developments and results of the theory of random parametric vibration that have been published since 1976 are reviewed. Part V of this series contains a survey of problems and results published through 1976. The present review is considered a complement of Part V.

82-231
Parameter Estimation in Structural Dynamics Models
D.R. Martinez
Sandia Natl. Labs., Albuquerque, NM, SAND-80-0135, 306 pp (Mar 1981)

Key Words: Parameter identification technique

A method is presented for the estimation of parameters in structural dynamics models. The key features of the method are as follows: estimates are obtained for the intrinsic (physical) parameters of the original model; the procedure is useful for structural dynamics problems limited to medium size, e.g., 1 to 200 degrees of freedom, where only a few, e.g., 1 to 10 key parameters are known; a constrained version of the discrete, iterated extended Kalman filter for parameter estimation is employed to obtain the estimates, utilizing frequency response function data as the measurements; a slight variation of modal synthesis transformation methods, including reduction of boundary coordinates, is developed to reduce the order of the original model when the frequency response function and its associated partial derivatives are needed for the estimation algorithm; and the magnitude of the frequency response function /H/ sub alpha beta /(omega)/ is used as data for the estimation procedure.

DESIGN TECHNIQUES

82-232
Interactive Optimal Design of Dynamically Loaded Structures
M.A. Bhatti, K.S. Pister, and E. Polak
American Society of Civil Engineers, NY, Rept. No. PREPRINT-80-635, NSF/RA-800474, 22 pp (1980) (Pres. at ASCE Convention and Exposition, Hollywood, FL, Oct 27-31, 1981)
PB81-195679

Key Words: Design techniques, Computer-aided techniques, Shock absorbers

An interactive software system for optimal design of civil engineering structures is described. This report reviews previous efforts to improve optimal design techniques leading to the present interactive computer system. It describes the design algorithm and discusses interactive implementation. As an example, optimal design of a nonlinear single degree of freedom impact absorber is presented. The system permits one to stop, restart, or modify any of the design parameters as the computation progresses. This results in substantial savings in computing time and in overall time needed to carry out a design.

COMPUTER PROGRAMS
(Also see No. 32)

82-233
Review and Summary of Computer Programs for Railway Vehicle Dynamics
W.D. Pilkey

School of Engrg. and Appl. Science, Virginia University, Charlottesville, VA, Rept. No. UVA-529162-MAE 80-101, FRA/ORD-81/17, 127 pp (Feb 1981) PB81-183857

Key Words: Railroad trains, Freight cars, Computer programs

To assess the state of development of computer programs which apply to the dynamics of rail vehicles, reviews were prepared of programs in six different categories: lateral stability, curving dynamics, wheel/rail contact, freight vehicle dynamics, analog hybrid simulation, and train dynamics. In addition, a number of European programs were summarized. A survey of users of the programs was also undertaken.

82-234

A Direct P-Delta Analysis Using Standard Plane Frame Computer Programs

A. Rutenberg

Faculty of Civil Engrg., Technion-Israel Inst. of Tech., Haifa, Israel, Computers Struc., 14 (1-2), pp 97-102 (1981) 5 figs, 2 tables, 14 refs

Key Words: Computer programs, Frames, Buildings

A simple technique is proposed that enables a direct second order analysis to be performed by means of first order plane frame computer programs. The geometric-stiffness matrix is modeled as a fictitious column with negative stiffness. The effect of additional moments due to eccentricity of axial force about the deflected shape is considered. The approach is also applicable to three dimensional problems and can also be used with nonlinear computer programs to evaluate the effect of sway on elastic-plastic frames.

82-235

CAL-GRAF - A Computer-Graphics Supplement for CAL

K.R. Leimbach

Ruhr-University, Bochum, W. Germany, Computers Struc., 14 (1-2), pp 135-141 (1981) 6 figs, 4 tables, 2 refs

Key Words: Graphic methods, Computer-aided techniques

The computer analysis language CAL developed by Wilson has proven to be a valuable tool in the teaching of modern methods of static and dynamic analysis of structural systems. The language has now been extended to cover the fundamental operations involved in composing graphic displays of various computational aspects of these methods on a screen and on paper. The computer graphics supplement CAL-GRAF covers the graphical representation of grids and functions. The purpose of the supplement is to allow students to graphically check the geometry and topology of their models, and to help them to interpret the results of their computations, such as displacements and stress resultants. CAL-GRAF consists of four types of operations: service operations, geometry processing, plotting of grids, and plotting of functions. Operations for extracting element topology tables and node and element related results have been added to CAL.

82-236

Application of a Large Scale State Estimator to the Vibrational Response of a Mechanical Structure

D.L. Lager

Lawrence Livermore Lab., Univ. of California, Livermore, CA, UCID-18824, 41 pp (Sept 18, 1980)

Key Words: Computer programs, Vibration response

The state estimator for large systems computer code was applied to the estimation of displacement time histories of points on a vibrating mechanical structure given noisy measurements at two locations on the strucutre. The goal was to demonstrate the feasibility of determining the motion of internal members of the structure given only noisy measurements from the exterior and a finite-element model of the structure. This study was done in four distinct phases, i.e., model development; simulation of displacements vs time; acquisition of noisy measurement data (computer simulated); and estimation of displacements from measurements.

82-237

Acoustic Properties of Turbofan Inlets

B.T. Zinn, R.K. Sigman, and S.J. Horowitz

School of Aerospace Engrg., Georgia Inst. of Tech., Atlanta, GA, Rept. No. NASA-CR-164218, 9 pp (Feb 1981)
N81-22834

Key Words: Computer programs, Finite element technique, Turbofan engines, Noise generation

The finite element codes were improved using Hermitian elements and numerical integration of element relations. The question of real variable versus complex variable formu-

lation was resolved and an integrated civil engineering system was implemented. Efforts are underway to restructure the program to obtain the most efficient use of array storage.

82-238

A Computer Simulation of the Transient Response of a 4 Cylinder Stirling Engine with Burner and Air Preheater in a Vehicle

W.R. Martini

Martini Engineering, Richland, WA, Rept. No. NASA-CR-165262, DOE/NASA/0226-1, 182 pp (Mar 1981) N81-22313

Key Words: Computer programs, Engines, Transient response

A series of computer programs are presented with full documentation which simulate the transient behavior of a modern 4 cylinder Siemens arrangement Stirling engine with burner and air preheater. Cold start, cranking, idling, acceleration through 3 gear changes and steady speed operation are simulated. Sample results and complete operating instructions are given. A full source code listing of all programs is included.

82-239

ORTURB: A Digital Computer Code to Determine the Dynamic Response of the Fort St. Vrain Reactor Steam Turbines

J.C. Conklin

Oak Ridge Natl. Lab., TN, Rept. No. ORNL/NUREG/TM-399, 39 pp (Apr 1981) NUREG/CR-1789

Key Words: Computer programs, Nuclear reactors, Steam turbines, Turbines

ORTURB is a computer code written specifically to calculate the dynamic behavior of the Fort St. Vrain (FSV) high-temperature gas-cooled reactor steam turbines. ORTURB uses a relationship derived for ideal gas flow in an interative fashion that minimizes computational time to determine the pressure and flow in the FSV steam turbines as a function of plant transient operating conditions. An important computer modeling characteristic, unique to FSV, is that the high-pressure turbine exhaust steam is used to drive the reactor core coolant circulators prior to entering the reheater. A feedwater heater dynamic simulation model utilizing seven state variables for each of the five heaters completes the ORTURB computer simulation of the regenerative Rankine cycle steam turbines.

82-240

A Microprocessor-Based Interactive Beam Analysis Program with Graphics - Dynamic and Static

Y.W. Luk and L.D. Mitchell

ASME Paper No. 81-DE-12

Key Words: Computer programs, Graphic methods, Transfer matrix method, Beams, Frequency response

This interactive graphics computer program, using transfer matrix method, provides four analyses for an undamped beam system: eigenvalue-eigenvector analysis, static response analysis, forced dynamic single frequency response analysis, and frequency response analysis. The program computes and plots deflection, slope, moment, and shear diagrams of a general beam.

82-241

PLUSH: A Computer Program for Probabilistic Finite Element Analysis of Seismic Soil-Structure Interaction

M.P. Romo-Organista, J. Chen, J. Lysmer, and H. Bolton Seed

Earthquake Engrg. Res. Ctr., Univ. of California, Berkeley, CA, Rept. No. UCB/EERC-77/01, 100 pp (Sept 1980) PB81-177651

Key Words: Computer programs, Interaction: soil-structure, Finite element technique, Seismic response

The computer program PLUSH is a further development of the complex response finite element program LUSH and FLUSH which were designed to perform seismic soil-structure interaction analyses. The new program retains the basic features of FLUSH, i.e., transmitting boundaries to simulate the infinite extent of the soil mass, beam elements, an approximate 3-D capability, deconvolution in the free field within the program, iteration on soil properties to simulate nonlinear effects, etc. The main difference between PLUSH and FLUSH is the way in which the input excitation is considered. Whereas in FLUSH the input excitation is specified as an acceleration time history, in PLUSH it is defined in terms of an input power spectrum or a median design response spectrum. In the latter case, the design response spectrum is converted into a corresponding power spectrum within the program. Thus PLUSH considers an infinite number of possible input motions simultaneously and the output, maximum accelerations, response spectra, etc., consist of statistical estimates of these variables with appropriate confidence limits.

GENERAL TOPICS

CONFERENCE PROCEEDINGS

82-242
Dynamics of Vehicles on Roads and Tracks
Seventh Intl. Symp., Cambridge, UK, Sept 7-11, 1981, Vehicle Systems Dynamics, 10 (2-3) (Sept 1981)

Key Words: Interaction: rail-vehicle, Proceedings

This special issue of the periodical, Vehicle Systems Dynamics, contains extensive summaries of 41 papers presented at the symposium sponsored by the International Association of Vehicle Systems Dynamics. The papers cover a wide range of topics in the dynamics of road, rail and other vehicles. Recent research findings in well-established areas of vehicle dynamics are presented while an effort has been made by the scientific committee to expand the domain of vehicle dynamics by seeking coverage of topics not formerly discussed at previous symposia in this series.

TUTORIALS AND REVIEWS
(See Nos. 83, 127, 173, 190, 230)

CRITERIA, STANDARDS, AND SPECIFICATIONS
(Also see Nos. 42, 43, 44)

82-243
Review and Refinement of ATC 3-06 Tentative Seismic Provisions. Report of Technical Committee 8: Architectural, Mechanical and Electrical
T.K. Faison
Natl. Engrg. Lab., Natl. Bureau of Standards, Washington, DC, Rept. No. NBSIR-80-2111-8, 44 pp (Oct 1980)
PB81-187593

Key Words: Buildings, Seismic design, Regulations

The Tentative Provisions for the Development of Seismic Regulations for Buildings were developed by the Applied Technology Council to present, in one comprehensive document, current state-of-knowledge pertaining to seismic engineering of buildings. The Tentative Provisions are in the process of being assessed by the building community. This report is one of a series of reports that document the deliberations of a group of professionals jointly selected by the Building Seismic Safety Council and the National Bureau of Standards and charged with reviewing the Tentative Provisions prior to the conduct of trial designs. The report contains recommendations and records of the committee charged with the review of the material related to architectural, mechanical and electrical provisions. The committee made seven general recommendations for revision and one recommendation for the addition of a new section on elevator design requirements.

82-244
Earthquake Resistant Structural Walls - Tests of Lap Splices
J.D. Aristizabal-Ochoa, A.E. Fiorato, and W.G. Corley
Construction Tech. Labs., Portland Cement Assoc., Skokie, IL, Rept. No. PCA-R/D-SER-1660, NSF/RA-800497, 123 pp (Dec 1980)
PB81-188369

Key Words: Buildings, Seismic design, Reinforced structures, Regulations

A test program to develop seismic design criteria for lap splices of reinforcing bars is described. Specifically, the effectiveness of tension lap splices under inelastic stress reversals is evaluated. Variables include load history, amount and configuration of lapped reinforcement, and amount of transverse hoop reinforcement around the lapped bars. Tests were performed on eight reinforced concrete column elements. Results indicate that distribution of transverse hoop reinforcement significantly influences performance.

82-245
Review and Refinement of ATC 3-06 Tentative Seismic Provisions. Report of Technical Committee 7: Wood
C.W.C. Yancey
Natl. Engrg. Lab., Natl. Bureau of Standards, Washington, DC, Rept. No. NBSIR-80-2111-7, 42 pp (Oct 1980)
PB81-187585

Key Words: Buildings, Seismic design, Wood, Regulations

The Tentative Provisions for the Development of Seismic Regulations for Buildings were developed by the Applied

Technology Council to present, in one comprehensive document, current state-of-knowledge pertaining to seismic engineering of buildings. The Tentative Provisions are in the process of being assessed by the building community. This report is one of a series of reports that documents the deliberations of a group of professionals jointly selected by the Building Seismic Safety Council and the National Bureau of Standards and charged with reviewing the Tentative Provisions prior to the conduct of trial designs. The report contains the recommendations and records of the committee charged with review of the provisions for the design and detailing of wood structures. The committee made 14 recommendations for revision to the Tentative Provisions.

82-246

Review and Refinement of ATC 3-06 Tentative Seismic Provisions. Report of Technical Committee 6: Steel

H.S. Lew

Natl. Engrg. Lab., Natl. Bureau of Standards, Washington, DC, Rept. No. NBSIR-80-2111-6, 38 pp (Oct 1980)

PB81 187577

Key Words: Buildings, Seismic design, Steel, Regulations

The Tentative Provisions for the Development of Seismic Regulations for Buildings were developed by the Applied Technology Council to present, in one comprehensive document, current state-of-knowledge pertaining to seismic engineering of buildings. The Tentative Provisions are in the process of being assessed by the building community. This report is one of a series of reports that documents the deliberations of a group of professionals jointly selected by the Building Seismic Safety Countil and the National Bureau of Standards and charged with reviewing the Tentative Provisions prior to the conduct of trial designs. The report contains the recommendations and records of the committee charged with review of the steel design provisions. The committee made 6 recommendations for revisions to the Tentative Provisions and three additional recommendations.

82-247

Review and Refinement of ATC 3-06 Tentative Seismic Provisions. Report of Technical Committee 3: Foundations

L.A. Salomone

Natl. Engrg. Lab., Natl. Bureau of Standards, Washington, DC, Rept. No. NBSIR-80-2111-3, 56 pp (Oct 1980)

PB81-187569

Key Words: Foundations, Buildings, Interaction: soil-structure, Seismic design, Regulations

This report documents the activities of Technical Committee 3: Foundations. Other committee reports are similarly available. The task of Technical Committee 3 was to review and refine Chapter 6, Soil-Structure Interaction and Chapter 7, Foundation Design Requirements in the ATC report (NBS SP-510) entitled, 'Tentative Provisions for the Development of Seismic Regulations for Buildings.' Two meetings were held. The minutes of these meetings and the findings/recommendations of Technical Committee 3 are presented in this report.

BIBLIOGRAPHIES

82-248

Acoustic Emission Techniques and Equipment for Nondestructive Testing: Non-nuclear Applications. January, 1966 - May, 1981 (Citations from the Metals Abstracts Data Base)

NTIS, Springfield, VA, Rept. for Jan 1966 - May 1981, 184 pp (May 1981)

PB81-863367

Key Words: Nondestructive tests, Testing techniques, Acoustic emission, Test equipment and instrumentation, Bibliographies

This retrospective bibliography contains citations concerning acoustic emission techniques and equipment for the nondestructive inspection and evaluation of a wide variety of non-nuclear materials, objects, and structures. Ultrasonic techniques are excluded. Contains 269 citations fully indexed, including a title list.

82-249

Aircraft Sonic Boom: Studies on Aircraft Flight, Aircraft Design, and Measurement. 1964 - March, 1981 (Citations from the NTIS Data Base)

NTIS, Springfield, VA, Rept. for 1964 - Mar 1981, 215 pp (Apr 1981)

PB81-805665

Key Words: Aircraft noise, Sonic boom, Bibliographies

The reports discuss aerodynamic design of aircraft and wings, flight characteristics and maneuvers, supersonic transport characteristics, acoustic fields and noise measurement, Gov-

ernment policies and regulations, meteorological parameters, shock waves, and supersonic and hypersonic wind tunnel tests, along with other theoretical and general investigations. Structural and biological effects are documented in separate published searches. This updated bibliography contains 207 citations, 8 of which are new entries to the previous edition.

82-250

Offshore Structures, January, 1974 - May, 1981 (Citations from Oceanic Abstracts)

NTIS, Springfield, VA, Rept. for Jan 1974 - May 1981, 139 pp (May 1981)
PB81-861403

Key Words: Bibliographies, Off shore structures, Fatigue life, Monitoring techniques

This retrospective bibliography contains citations concerning the dynamic behavior, and fatigue and failure analysis of offshore structures for safety considerations and for disaster prevention. Some attention is given to specific offshore structures and to monitoring techniques and systems. Contains 173 citations fully indexed and including a title list.

82-251

Air Force Academy Aeronautics Digest - Fall/Summer 1980

Dept. of Aeronautics, U.S. Air Force Academy, CO, Rept. No. USAFA-TR-81-4, 143 pp (May 1981)

Key Words: Bibliographies, Aerodynamic characteristics, Propulsion systems, Test equipment and instrumentation

This digest covers unclassified research in aeronautics performed at the United States Air Force Academy during the six months ending 15 January 1981. This report includes technical papers in the specific areas of aerodynamics, propulsion, experimental instrumentation, biomechanics, engineering education, and aeronautical history.

82-252

Air Force Academy Aeronautics Digest - Spring 1979

Dept. of Aeronautics, U.S. Air Force Academy, CO, Rept. No. USAFA-TR-79-7, 162 pp (July 1979)

Key Words: Bibliographies, Aerodynamic characteristics, Propulsion systems, Test equipment and instrumentation

This digest covers unclassified research in aeronautics performed at the United States Air Force Academy during the six months ending 1 July 1979. This report includes individual technical papers in the specific areas of aerodynamics, fluid mechanics, experimental instrumentation, engineering education and thermodynamics and heat transfer.

82-253

Seismic Design for Buildings and Building Codes. January, 1970 - February, 1981 (Citations from the Engineering Index Data Base)

NTIS, Springfield, VA, Rept. for Jan 1970 - Feb 1981, 59 pp (Mar 1981)
PB81-862070

Key Words: Buildings, Foundations, Seismic design, Standards and codes, Bibliographies

This retrospective bibliography contains citations concerning seismic design criteria and building codes for various types of non-nuclear structures, principally buildings and their foundations. The design criteria for seismic protection are discussed both in general and with respect to specific types of structures. Cases of actual damage assessment for earthquake resistant and non-resistant structures are included. Contains 56 citations fully indexed, including a title list.

USEFUL APPLICATIONS

82-254

Burn-in: Which Environmental Stress Screens Should Be Used

D. Karam
Rome Air Development Ctr., Griffiss AFB, NY, Rept. No. RADC-TR-81-87, 64 pp (Mar 1981)
AD-A099 207

Key Words: Environmental simulation, Random vibration, Thermal excitation, Vibration tests

This report is based on a literature survey of stress screening studies and concludes that thermal cycling and random vibration are the two most powerful screens. Reports dealing with thermal cycling and random vibration tests are discussed and some conclusions and areas that need further research are also given for a military standard on burn-in based on the findings in this report.

AUTHOR INDEX

PERIODICALS SCANNED

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ACTA MECHANICA Springer-Verlag New York, Inc. 175 Fifth Ave. New York, NY 10010	Acta Mech.
ACUSTICA S. Hirzel Verlag, Postfach 347 D-700 Stuttgart 1 W. Germany	Acustica
AERONAUTICAL JOURNAL Royal Aeronautical Society 4 Hamilton Place London W1V 0BQ, UK	Aeronaut. J.
AERONAUTICAL QUARTERLY Royal Aeronautical Society 4 Hamilton Place London W1V 0BQ, UK	Aeronaut. Quart.
AIAA JOURNAL American Institute of Aeronautics and Astronautics 1290 Avenue of the Americas New York, NY 10019	AIAA J.
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BULLETIN OF JAPAN SOCIETY OF MECHANICAL ENGINEERS Japan Society of Mechanical Engineers Sanshin Hokusei Bldg. H-9 Yoyogi 2-chome Shibuya-ku Tokyo 151, Japan	Bull. JSME
BULLETIN OF SEISMOLOGICAL SOCIETY OF AMERICA Bruce A. Bolt Box 826 Berkeley, CA 94705	Bull. Seismol. Soc. Amer.
CIVIL ENGINEERING (NEW YORK) ASCE United Engineering Center 345 E. 47th St. New York, NY 10017	Civ. Engrg. (N.Y.)
CLOSED LOOP MTS Systems Corp. P.O. Box 24012 Minneapolis, MN 55474	Closed Loop
COMPUTERS AND STRUCTURES Pergamon Press Inc. Maxwell House, Fairview Park Elmsford, NY 10523	Computers Struc.
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PUBLICATION AND ADDRESS	ABBREVIATION
INTERNATIONAL JOURNAL OF FATIGUE IPI Science and Technology Press Ltd. P.O. Box 63, Westbury House, Bury Street Guildford, Surrey, England GU2 5BH	Intl. J. Fatigue
INTERNATIONAL JOURNAL OF MACHINE TOOL DESIGN AND RESEARCH Pergamon Press Inc. Maxwell House, Fairview Park Elmsford, NY 10523	Intl. J. Mach. Tool Des. Res.
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JOURNAL DE MECANIQUE Gauthier-Villars C.D.R. - Centrale des Revues B.P. No. 119, 93104 Montreuil Cedex-France	J. de mecanique
JOURNAL OF MECHANICAL ENGINEERING SCIENCE Institution of Mechanical Engineers 1 Birdcage Walk, Westminster London SW1 H9, UK	J. Mech. Engrg. Sci.
JOURNAL OF THE MECHANICS AND PHYSICS OF SOLIDS Pergamon Press Inc. Maxwell House, Fairview Park Elmsford, NY 10523	J. Mechanics Phys. Solids
JOURNAL OF PETROLEUM TECHNOLOGY Society of Petroleum Engineers 6200 N. Central Expressway Dallas, TX 75206	J. Pet. Tech.
JOURNAL OF PHYSICS: E SCIENTIFIC INSTRUMENTS American Institute of Physics 335 East 45th St. New York, NY 10017	J. Phys. E: Sci. Instrum.
JOURNAL OF SHIP RESEARCH Society of Naval Architects and Marine Engineers 20th and Northhampton Sts. Easton, PA 18042	J. Ship Res.
JOURNAL OF SOUND AND VIBRATION Academic Press 111 Fifth Ave. New York, NY 10019	J. Sound Vib.

PUBLICATION AND ADDRESS	ABBREVIATION
JOURNAL OF SPACECRAFT AND ROCKETS American Institute of Aeronautics and Astronautics 1290 Avenue of the Americas New York, NY 10019	J. Spacecraft Rockets
JOURNAL OF TESTING AND EVALUATION (ASTM) American Society for Testing and Materials 1916 Race St. Philadelphia, PA 19103	J. Test Eval. (ASTM)
KONSTRUKTION Spring Verlag 3133 Connecticut Ave., N.W. Suite 712 Washington, D.C. 20008	Konstruktion
LUBRICATION ENGINEERING American Society of Lubrication Engineers 838 Busse Highway Park Ridge, IL 60068	Lubric. Engrg.
MACHINE DESIGN Penton Publishing Co. Penton Bldg. Cleveland, *OH* 44113	Mach. Des.
MASCHINENBAUTECHNIK VEB Verlag Technik Oranienburger Str. 13/14 102 Berlin, E. Germany	Maschinen-bautechnik
MECCANICA Pergamon Press, Inc. Maxwell House, Fairview Park Elmsford, NY 10523	Meccanica
MECHANICAL ENGINEERING American Society of Mechanical Engineers 345 East 45th St. New York, NY 10017	Mech. Engrg.
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MTZ MOTORTECHNISCHE ZEITSCHRIFT Franckh'sche Verlagshandlung Pfizerstrasse 5-7 7000 Stuttgart 1 W. Germany	MTZ Motor-tech. Z.
NAVAL ENGINEERS JOURNAL American Society of Naval Engineers, Inc. Suite 507, Continental Bldg. 1012 - 14th St., N.W. Washington, D.C. 20005	Naval Engr. J.
NOISE AND VIBRATION CONTROL Trade and Technical Press Ltd. Crown House, Morden Surrey SM4 5EW, UK	Noise Vib. Control
NOISE CONTROL ENGINEERING P.O. Box 3206, Arlington Branch Poughkeepsie, NY 12603	Noise Control Engrg.
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NUCLEAR ENGINEERING AND DESIGN North Holland Publishing Co. P.O. Box 3489 Amsterdam, The Netherlands	Nucl. Engrg. Des.
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PACKAGE ENGINEERING 5 S. Wabash Ave. Chicago, IL 60603	Package Engrg.
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POWER P.O. Box 521 Hightston, NJ 08520	Power
POWER TRANSMISSION DESIGN Industrial Publishing Co. Division of Pittway Corp. 812 Huron Rd. Cleveland, OH 44113	Power Transm. Des.
QUARTERLY JOURNAL OF MECHANICS AND APPLIED MATHEMATICS Wm. Dawson & Sons, Ltd. Cannon House Folkestone, Kent, UK	Quart. J. Mechanics Appl. Math.
REVUE ROUMAINE DES SCIENCES TECHNIQUES, SERIE DE MECANIQUE APPLIQUEE Editions De L'Academie De La Republique Socialiste de Roumaine 3 Bis Str., Gutenberg, Bucurest, Romania	Rev. Roumaine Sci. Tech., Mecanique Appl.
REVIEW OF SCIENTIFIC INSTRUMENTS American Institute of Physics 335 East 45th St. New York, NY 10017	Rev. Scientific Instr.
SAE PREPRINTS Society of Automotive Engineers Two Pennsylvania Plaza New York, NY 10001	SAE Prepr.
SIAM JOURNAL ON APPLIED MATHEMATICS Society for Industrial and Applied Mathematics 33 S. 17th St. Philadelphia, PA 19103	SIAM J. Appl. Math.

PUBLICATION AND ADDRESS	ABBREVIATION
SIAM JOURNAL ON NUMERICAL ANALYSIS Society for Industrial and Applied Mathematics 33 S. 17th St. Philadelphia, PA 19103	SIAM J. Numer. Anal.
STROJNICKY ČASOPIS Red. Strojnickeno Casopisu ČSAV A SAV USTAV MECHANIKY STROJOV SAV Bratislava-Patronka, Dubrovska cesta, ČSSR Czechoslovakia	Strojnicky Časopis
S/V, SOUND AND VIBRATION Acoustic Publications, Inc. 27101 E. Oviat Rd. Bay Village, OH 44140	S/V, Sound Vib.
TECHNISCHES MESSEN - ATM R. Oldenburg Verlag GmbH Rosenheimer Str. 145 8 München 80, W. Germany	Techn. Messen-ATM
TEST 61 Monmouth Road Oakhurst, NJ 07755	Test
TRIBOLOGY INTERNATIONAL IPC Science and Technology Press Ltd. Westbury House P.O. Box 63, Bury Street Guildford, Surrey GU2 5BH, UK	Tribology Intl.
TURBOMACHINERY INTERNATIONAL Turbomachinery Publications, Inc. 22 South Smith St. Norwalk, CT 06855	Turbomach. Intl.
VDI ZEITSCHRIFT Verein Deutscher Ingenieur GmbH Postfach 1139, Graf-Recke Str. 84 4 Düsseldorf 1, Germany	VDI Z.
VDI FORSCHUNGSHEFT Verein Deutscher Ingenieur GmbH Postfach 1139, Graf-Recke Str. 84 4 Düsseldorf 1, Germany	VDI Forsch.
VEHICLE SYSTEMS DYNAMICS Swets and Zeitlinger N.V. 347 B. Herreweg Lisse, The Netherlands	Vehicle Syst. Dyn.
VIBROTECHNIKA Kauno Polytechnikos Institutas 2 Donelaičio g-ve 17 233000 Kaunas Lithuanian SSR	Vibro-technika
WAVE MOTION North Holland Publishing Co. P.O. Box 211 1000 AE Amsterdam The Netherlands	Wave Motion
WEAR Elsevier Sequoia S.A. P.O. Box 851 1001 Lausanne 1, Switzerland	Wear
ZEITSCHRIFT FÜR ANGEWANDTE MATHEMATIK UND MECHANIK Akademie Verlag GmbH Leipziger Str. 3-4 108 Berlin, Germany	Z. angew. Math. Mech.
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THE SHOCK AND VIBRATION BULLETIN, UNITED STATES NAVAL RESEARCH LABORATORIES, ANNUAL PROCEEDINGS Shock and Vibration Information Center Naval Research Lab., Code 5804 Washington, D.C. 20375	Shock Vib. Bull., U.S. Naval Res. Lab., Proc.

CALENDAR

FEBRUARY 1982

22-26 SAE Congress and Exposition [SAE] Detroit, MI *(SAE Hqs.)*

MARCH 1982

29-Apr 1 Design Engineering Conference and Show [ASME] Chicago, IL *(ASME Hqs.)*

30-Apr 1 Machinery Vibration Monitoring and Analysis Meeting [Vibration Institute] Oak Brook, IL *(Ronald L. Eshleman, Director, Vibration Institute, 101 W. 55th St., Suite 206, Clarendon Hills, IL 60514 - (312) 654-2254)*

APRIL 1982

14-16 Fatigue Conference and Exposition [SAE] Dearborn, MI *(SAE Hqs.)*

18-22 Gas Turbine Conference and Products Show [ASME] London, England *(ASME Hqs.)*

20-22 Mechanical Failures Prevention Group 35th Symposium [National Bureau of Standards] Gaithersburg, MD *(Dr. James G. Early, National Bureau of Standards, Bldg. 223/Room A-113, Washington, DC 20234 - (301) 921-2976)*

20-23 Institute of Environmental Sciences' 28th Annual Technical Meeting [IES] Atlanta, GA *(IES, 940 E. Northwest Highway, Mt. Prospect, IL 60056 - (312) 255-1561)*

22-23 13th Annual Pittsburgh Conference on Modeling and Simulation [School of Engineering, Univ. of Pittsburgh] Pittsburgh, PA *(William G. Vogt or Marlin H. Mickle, Modeling and Simulation Conf., 348 Benedum Engrg. Hall, Univ. of Pittsburgh, Pittsburgh, PA 15261)*

26-30 Acoustical Society of America, Spring Meeting [ASA] Chicago, IL *(ASA Hqs.)*

MAY 1982

12-14 Pan American Congress on Productivity [SAE] Mexico City *(SAE Hqs.)*

24-26 Commuter Aircraft and Airline Operations Meeting [SAE] Savannah, GA *(SAE Hqs.)*

JUNE 1982

7-11 Passenger Car Meeting [SAE] Dearborn, MI *(SAE Hqs.)*

JULY 1982

13-15 'Environmental Engineering Today' Symposium and Exhibition [SEE] London, England *(SEECO 82 Organisers, Owles Hall, Buntingford, Herts. SG9 9PL, England - Tel: Royston (0763) 71209)*

19-21 12th Intersociety Conference on Environmental Systems [SAE] San Diego, CA *(SAE Hqs.)*

AUGUST 1982

16-19 West Coast International Meeting [SAE] San Francisco, CA *(SAE Hqs.)*

SEPTEMBER 1982

13-16 International Off-Highway Meeting & Exposition [SAE] Milwaukee, WI *(SAE Hqs.)*

OCTOBER 1982

4-6 Convergence '82 [SAE] Dearborn, MI *(SAE Hqs.)*

4-7 Symposium on Advances and Trends in Structural and Solid Mechanics [George Washington Univ. & NASA Langley Res. Ctr.] Washington, DC *(Prof. Ahmed K. Noor, Mail Stop 246, GWU-NASA Langley Res. Ctr., Hampton, VA 23665 - (804) 827-2897)*

12-15 Stapp Car Crash Conference [SAE] Ann Arbor, MI *(SAE Hqs.)*

25-28 Aerospace Congress & Exposition [SAE] Anaheim, CA *(SAE Hqs.)*

26-28 53rd Shock and Vibration Symposium [Shock and Vibration Information Center, Washington, DC] Danvers, MA *(Henry C. Pusey, Director, SVIC, Naval Research Lab., Code 5804, Washington, DC 20375)*

NOVEMBER 1982

8-10 International Modal Analysis Conference [Union College] Orlando, Florida *(Prof. Raymond Eisenstadt, Union College, Graduate and Continuing Studies, Wells House, 1 Union Ave., Schenectady, NY 12308 - (518) 370-6288)*

8-12 Acoustical Society of American, Fall Meeting [ASA] Orlando, Florida *(ASA Hqs.)*

8-12 Truck Meeting & Exposition [SAE] Indianapolis, IN *(SAE Hqs.)*

CALENDAR ACRONYM DEFINITIONS AND ADDRESSES OF SOCIETY HEADQUARTERS

AFIPS: American Federation of Information Processing Societies
210 Summit Ave., Montvale, NJ 07645

AGMA: American Gear Manufacturers Association
1330 Mass Ave., N.W.
Washington, D.C.

AHS: American Helicopter Society
1325 18 St. N.W.
Washington, D.C. 20036

AIAA: American Institute of Aeronautics and Astronautics, 1290 Sixth Ave.
New York, NY 10019

AIChE: American Institute of Chemical Engineers
345 E. 47th St.
New York, NY 10017

AREA: American Railway Engineering Association
59 E. Van Buren St.
Chicago, IL 60605

ARPA: Advanced Research Projects Agency

ASA: Acoustical Society of America
335 E. 45th St.
New York, NY 10017

ASCE: American Society of Civil Engineers
345 E. 45th St.
New York, NY 10017

ASME: American Society of Mechanical Engineers
345 E. 45th St.
New York, NY 10017

ASNT: American Society for Nondestructive Testing
914 Chicago Ave.
Evanston, IL 60202

ASQC: American Society for Quality Control
161 W. Wisconsin Ave.
Milwaukee, WI 53203

ASTM: American Society for Testing and Materials
1916 Race St.
Philadelphia, PA 19103

CCCAM: Chairman, c/o Dept. ME, Univ. Toronto,
Toronto 5, Ontario, Canada

ICF: International Congress on Fracture
Tohoku Univ.
Sendai, Japan

IEEE: Institute of Electrical and Electronics Engineers
345 E. 47th St.
New York, NY 10017

IES: Institute of Environmental Sciences
940 E. Northwest Highway
Mt. Prospect, IL 60056

IFToMM: International Federation for Theory of Machines and Mechanisms
U.S. Council for TMM
c/o Univ. Mass., Dept. ME
Amherst, MA 01002

INCE: Institute of Noise Control Engineering
P.O. Box 3206, Arlington Branch
Poughkeepsie, NY 12603

ISA: Instrument Society of America
400 Stanwix St.
Pittsburgh, PA 15222

ONR: Office of Naval Research
Code 40084, Dept. Navy
Arlington, VA 22217

SAE: Society of Automotive Engineers
400 Commonwealth Drive
Warrendale, PA 15096

SEE: Society of Environmental Engineers
6 Conduit St.
London W1R 9TG, UK

SESA: Society for Experimental Stress Analysis
21 Bridge Sq.
Westport, CT 06880

SNAME: Society of Naval Architects and Marine Engineers
74 Trinity Pl.
New York, NY 10006

SPE: Society of Petroleum Engineers
6200 N. Central Expressway
Dallas, TX 75206

SVIC: Shock and Vibration Information Center
Naval Research Lab., Code 5804
Washington, D.C. 20375

URSI-USNC: International Union of Radio Science - U.S. National Committee
c/o MIT Lincoln Lab.
Lexington, MA 02173

PUBLICATION POLICY

Unsolicited articles are accepted for publication in the Shock and Vibration Digest. Feature articles should be tutorials and/or reviews of areas of interest to shock and vibration engineers. Literature review articles should provide a subjective critique/summary of papers, patents, proceedings, and reports of a pertinent topic in the shock and vibration field. A literature review should stress important recent technology. Only pertinent literature should be cited. Illustrations are encouraged. Detailed mathematical derivations are discouraged; rather, simple formulas representing results should be used. When complex formulas cannot be avoided, a functional form should be used so that readers will understand the interaction between parameters and variables.

Manuscripts must be typed (double-spaced) and figures attached. It is strongly recommended that line figures be rendered in ink or heavy pencil and neatly labeled. Photographs must be unscreened glossy black and white prints. The format for references shown in DIGEST articles is to be followed.

Manuscripts must begin with a brief abstract, or summary. Only material referred to in the text should be included in the list of References at the end of the article. References should be cited in text by consecutive numbers in brackets, as in the example below.

> **Unfortunately, such information is often unreliable, particularly statistical data pertinent to a reliability assessment, as has been previously noted [1].**
>
> **Critical and certain related excitations were first applied to the problem of assessing system reliability almost a decade ago [2]. Since then, the variations that have been developed and the practical applications that have been explored [3-7] indicate that . . .**

The format and style for the list of References at the end of the article are as follows:

- **each citation number as it appears in text (not in alphabetical order)**
- **last *name* of *author/editor* followed by initials or first name**
- **titles of articles within quotations, titles of books underlined**
- **abbreviated title of journal in which article was published (see Periodicals Scanned list in January, June, and December issues)**
- **volume, number or issue, and pages for *journals; publisher* for books**
- **year of publication in parentheses**

A sample reference list is given below.

1. **Platzer, M.F., "Transonic Blade Flutter - A Survey," Shock Vib. Dig., 7 (7), pp 97-106 (July 1975).**
2. **Bisplinghoff, R.L., Ashley, H., and Halfman, R.L., Aeroelasticity, Addison-Wesley (1955).**
3. **Jones, W.P., (Ed.), "Manual on Aeroelasticity," Part II, Aerodynamic Aspects, Advisory Group Aeronaut. Res. Devel. (1962).**
4. **Lin, C.C., Reissner, E., and Tsien, H., "On Two-Dimensional Nonsteady Motion of a Slender Body in a Compressible Fluid," J. Math. Phys., 27 (3), pp 220-231 (1948).**
5. **Landahl, M., Unsteady Transonic Flow, Pergamon Press (1961).**
6. **Miles, J.W., "The Compressible Flow Past an Oscillating Airfoil in a Wind Tunnel," J. Aeronaut. Sci., 23 (7), pp 671-678 (1956).**
7. **Lane, F., "Supersonic Flow Past an Oscillating Cascade with Supersonic Leading Edge Locus," J. Aeronaut. Sci., 24 (1), pp 65-66 (1957).**

Articles for the DIGEST will be reviewed for technical content and edited for style and format. Before an article is submitted, the topic area should be cleared with the editors of the DIGEST. Literature review topics are assigned on a first come basis. Topics should be narrow and well-defined. Articles should be 1500 to 2500 words in length. For additional information on topics and editorial policies, please contact:

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